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This research project examines the available evidence concerning what will be the probable effective engagement range(s) for the tube launched, optically tracked, wire-command link (TOW) antitank guided missile system in the defense in the Main Battle Area of Central Europe during the period 1978-1983.

This paper focuses on one dominant question - if, by virtue of the environmental and tactical limitations imposed on the TOW system, the antitank battle cannot begin at 3,000 meters, at what range or envelope of ranges will the TOW

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antitank battle probably become effective? To answer this question, this study concentrated on U.S./Soviet technical and tactical publications, terrain evaluations, interviews with tactical commanders and representatives of allied nations employing the TOW, and a survey distributed among the 1977/78 Command and General Staff College student body and faculty.

The results of the investigation determined that, while some engagements may come at 3,000 meters, the preponderance of evidence indicates that the probable effective TOW engagement range will fall between 1,500 and 2,000 meters. The factors of terrain, weather and combat obscuration will cause engagements between opposing forces to be frequently fought at very close ranges even though the TOW is capable of engaging at longer ranges.

TOW ENGAGEMENT IN THE ACTIVE DEFENSE...

3000 METERS OR LESS?

A thesis presented to the Faculty of the U.S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE

by

JOHN R. ANGOLIA, LTC, USA
B.A., The Virginia Military Institute, 1959

Fort Leavenworth, Kansas
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, Research Advisor

, Member, Graduate Faculty

, Member, Consulting Faculty

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ABSTRACT

This research project is designed to examine the available evidence concerning what will be the probable effective engagement range or ranges for the tube launched, optically tracked, wire-command link (TOW) antitank guided missile system in the conduct of the defense in the Main Battle Area of Central Europe during the period 1978-1983.

This paper focuses on one dominant question - if, by virtue of the environmental and tactical limitations imposed on the TOW system, the antitank battle cannot begin at 3,000 meters, at what range or envelope of ranges will the TOW antitank battle probably become effective? In order to answer this question, this study concentrated on U.S. and Soviet technical and tactical publications, scientific terrain evaluations, interviews with tactical commanders and representatives of allied nations armed with the TOW, and a survey distributed among the 1977/78 Command and General Staff College student body and faculty.

The results of the investigation determined that, while some engagements may come at 3,000 meters or more, the preponderance of evidence would indicate that the probable effective TOW engagement range will fall between 1,500 and 2,000 meters. The factors of terrain, weather and combat obscuration will cause engagements between opposing forces to be frequently fought at very close ranges even though the TOW is capable of engaging at longer ranges.

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INTRODUCTION

Western military analysts perceive that the greatest possible threat to Western security will be directed against Western Europe, with the threat coming from the Soviet Union and her Warsaw Pact allies. Therefore, US military doctrinal writing has been focused on this area and the potential threat force. The United States intelligence community has expended considerable resources and energy in determining the military balance between the United States and the Soviet Union, and the forces of NATO and those of the Warsaw Pact. In both cases, the West is challenged by a numerical superiority--especially in the area of tanks, armored fighting vehicles and artillery.

Analysis of the lessons learned from the October, 1973, Middle-East War has caused US tacticians to seek a solution to the problem of target density. The more than 2,700 tanks destroyed or damaged by tank fire and antitank guided missiles (ATGMs) led analysts to the conclusion that the combined tank/ATGM was an effective counter to a mass of attacking armor. Because of its increased range, the heavy antitank guided missile system, with its proven accuracy and kill capability, has become a prime ingredient in the U.S. antitank defensive system. The tube-launched, optically tracked, wire-command link (TOW) ATGM has almost twice the maximum effective range of the main battle tank--3,000 meters vs 1,800 meters--and to borrow from an existing Training and Doctrine Command (TRADOC) cliche; "what it can see, it can hit, and what it can hit, it can kill."

The TOWs' 3,000 meter range capability has been emphasized in doctrinal writing and tactical teachings at the various Army service schools, and by implication, the desired engagement range of the TOW system is 3,000 meters to optimize its range/lethality characteristics. However, there are a number of prevailing conditions existing in the European environment that would tend to preclude a major battle being entered into at 3,000 meters--obscuration caused by industrial haze, persistent morning ground fog, low overcast, snow, and rain; line-of-sight disruption caused by trees and other natural growth, rolling and mountainous terrain, and built up areas. If, by virtue of the limitations imposed on the TOW, the antitank battle cannot begin at 3,000 meters, the question follows, at what range will the antitank battle begin? It is this question that this paper attempts to answer. To do so, certain limiting constraints govern this study:

a. Primary discussion will be restricted to the V (US) Corps sector of Allied Command Europe, with periodic reference made to the VII (US) Corps sector in the south. The reason for this restriction is that it is in the US sectors that the active defense doctrine will be employed using the TOW system as the principal long range antitank guided missile system.

b. The conduct of the defense in the Main Battle Area (MBA) will be the primary discussion vehicle since it is here that the critical battle will be fought and decided.

c. While addressed in the discussion, crew training will not be considered to be a restrictive factor in the effective employment of the TOW.

d. Discussion will focus on the 1978-1983 timeframe. It is anticipated that some of the numerical superiority will have been overtaken by 1983, thus taking some of the pressure off the TOW system. Additionally, it is further anticipated that a thermal sight system will be fully operational by 1983, thus negating most of the problems of obscuration attributed to the existing TOW system. For the purpose of this study, the thermal sight system is not considered to be operational (fielded) for the TOW system during the subject timeframe.

e. The TOW system reliability is accepted to be 99%[1].

Some additional answers to other nagging questions may fall out as a result of this study:

a. Will the TOW be as effective on the modern battlefield as it has demonstrated in a benign test environment and in battle simulations?

b. Has inordinate stress been placed on the TOW gunner as being the answer to the enemy mass of armored vehicles?

c. If the main battle will not be fought at 3,000 as currently perceived, then where will it be fought?

d. What will be the impact on the active defensive doctrine should the major battle not begin at 3,000 meters?

e. If the TOW system is not the most effective weapons system to begin the antitank battle, what system is?

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[1]"TOW System Evaluation," DEV Report No. 3, Fort Benning, GA., Dec 1976. pg. 5.

f. Are there technological advances on the horizon that will change the existing concept of antitank engagement?

By assessing the TOW system and the environmental area of Central Europe, an effort will be made to show where the antitank battle will begin. If the engagement is not 3,000 meters as currently perceived, then the study will attempt to show at what range the battle will probably begin.

The principle source for documentation fall into four general areas. These are:

1. US and Soviet publications dealing with tactics in general and the TOW antitank guided missile system specifically.

2. Interviews with TOW gunners, tactical commanders and representatives of allied nations armed with the TOW system.

3. First hand observation of the US V and VII Corps areas of operation.

4. A survey distributed among the 1977/78 Command and General Staff College student body and faculty.

For author background see Appendix A.

CHAPTER 1

BACKGROUND

During the early 1960's, the Soviet Union in conjunction with the Warsaw Pact undertook an extensive expansion and rearmament effort. Years of research and development in land, sea and air weaponry coincided, and the Soviet Union fielded some of the most advanced weapons systems the world has seen to date. By early 1970's, United States intelligence agencies acknowledged that the Soviet Union not only had more advanced military weaponry, but also had considerably more in numbers of tanks, armored fighting vehicles, artillery, and held a slight edge in aircraft. By the mid-1970's the US press was openly acknowledging that the Soviet Union and the Warsaw Pact was numerically superior to the US and NATO forces in men and equipment.

	(Total Inventory)		(Deployment in North/Central Europe)	
	US	USSR	WP	NATO
Divisions	16	168	70	27
Men	228,000	535,000	945,000	630,000
Tanks	11,600	43,000	13,500	7,000*
APC's	22,000	47,000		
Artillery	5,000	21,700	10,000	2,700

*Does not include 485 French tanks

Figure 1[2]

Soviet expansion of military arms came at a time when US attentions were directed in the area of Southeast Asia, fighting a war costing over a million dollars a day. Military dollars were not readily available to go into production of new US weapons systems to openly compete with

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[2] "The Military Balance, 1977-1978," The International Institute for Strategic Studies, London. 1977.

the Soviet buildup. Even research and development programs were affected. Systems such as the B-1 bomber and the XM-1 main battle tank were temporarily shelved. When the war drew to a close, a dollar-conscious Congress was not prepared to release the expenditures necessary to begin an immediate effort to close the gap that had grown between US and Soviet equipment inventories. Military analysts agreed that it might be as long as ten years before the gap could effectively be closed. This left the Soviets with an existing numerical superiority in major items of equipment. This quantitative advantage provided the leverage that could possibly influence the strategic world balance. The U.S. Army Training and Doctrine Command (TRADOC) undertook steps that would assist in placing the US military on an equal footing with the Soviets, while Congress and industry responded by providing the means for producing the needed advanced weaponry in quantities that would neutralize the potential Soviet threat. Time was needed to equalize the imbalance, and US military leaders faced the reality that modern warfare was an expensive proposition. Fielding military equipment on a one-to-one ratio against the Soviet Union was no longer a viable alternative. US and Soviet leaders embarked on a policy of detente--a trade-off of military hardware, troops and other strategic agreements designed to lessen world tensions and reduce the subtle arms race that had developed.

While the two main players were on center stage attempting to vie for the strategic advantage, bit players were standing in the wings readying for a starring role of their own. They entered with their dramatic performance in early October, 1973, and the props they used were to have an unforeseen impact on modern mobile warfare. The Egyptians

and Syrians unleashed a surprise attack against the Israelies with such surprising success that it caught even the Arabs unprepared to follow up their gains. The Israelies decided to first eliminate the Arab threat to the east, which she quickly did through a series of masterful tank battles, and then direct her full attention against the Egyptians.[3] In the 1967 War of Attrition, the Israelies had effectively used the tank and the airplane to win the decisive victory. Why not once again in 1973? This time the Egyptians used massive amounts of air defense weapons to neutralize the air threat (until such time the Egyptians outran their air defense cover). But it was not the air defense systems employed so effectively that made the major world powers sit back and take another look at modern tactics. It was the large quantities and the effective employment of Arab antitank guided missiles, in particular the SAGGER ATGM, that so surprised the Israelies, and had US military analysts taking a long hard look at the developments taking place on the Middle-East battlefield.

Before the dust of the October, 1973, War had settled, some analysts were proclaiming that, with the advent of the now battle-tested antitank guided missile tactics, the supremacy of the tank was at an end. Certainly such an assessment was premature. Subsequent analysis by both US and Soviet tactical analysts has determined that the tank remains a viable weapon on the modern battlefield. Soviet military writers had this to say about the viability of the tank on the modern battlefield even before the 1973 Mid-East War:

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[3]London Sunday Times, The Yom Kippur War, Doubleday and Co., Inc., Garden City, NY, 1974, p. 204.

> "Is it possible that ATGM's are the perfect weapon that will make tanks obsolete just as cavalry was made obsolete by machine-guns, artillery and aircraft? This question would be justified if ATGM's did not have inherent shortcomings and tanks were not reinforced by infantry, artillery, aircraft and nuclear weapons.
>
> Tanks continue to be a powerful and redoubtable attack weapon because the whole of the antitank defences in the chosen direction of attack can be destroyed or reliably neutralised, and favorable conditions for a successful offensive of armoured troops can be created."[4]

While the Soviets were not about to scrap their enormous tank force, they still had to contend with the lessons learned regarding the lethality of ATGMs. This dilemma is clearly reflected in the writings of the late Minister of Defense, Marshal Grechko, when he wrote in 1975,

> "The continuing process of perfecting the antitank weapon has placed before science and technology a serious task in the business of tangibility raising the viability of tank troops and developing more effective ways and means of reliably suppressing antitank defense."[5]

The tactics that evolved in the Sinai resulted in, among other considerations, a threefold realization that:

a. No single combat arm was capable of winning a single major victory, but it was a suitable balance of arms--the combined arms team that was required to get the job done.

b. For the first time in modern warfare the infantryman was provided an effective means to destroy tanks at a range well beyond the effective range of the tank's main tube.

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[4]Biryukov, G. and Melnikov, G., Antitank Warfare, Progress Publishers, Moscow, 1972, p. 82.

[5]"Understanding Soviet Military Developments," Office of the Asst Chief of Staff for Intelligence, Washington, D.C., April 1977, p. 27.

c. A relatively inexpensive weapon system had proved the equal of the expensive and more sophisticated tank.

Certainly the ATGM was not new to US military analysts as the TOW antitank guided missile, a second generation system, was introduced as a helicopter-launched weapons system in Vietnam. However, the Middle-East War and the events in Vietnam now provided tactical analysts an opportunity to study the battlefield effectiveness and take a close look at the tactical employment of the ATGM. Most important was the fact that the lessons learned from the October, 1973, Middle-East War triggered a thinking process at TRADOC that resulted in a major reevaluation of US tactical doctrine, the results of which have and will continue to shape US tactics well into the 1980's.

Supported by information provided by battlefield observers and material funneled directly to the US by the Israeli Defense Force, the US relearned the lesson of the effectiveness of employing combined arms--especially in an era of high-speed mobile armored warfare. The destructive capability and accuracy of the ATGM was proven on the battlefield, and now provided the US with a means that would partially close the gap between the 12,000 US and 43,000 Soviet tanks. The results of the US findings were ultimately expressed in FM 100-5 in the form of a dynamic new tactic. The combined arms team, the tank-infantry team supported by artillery and air, received new stress, but it was the advent of the active defense that was to have such an impact on the future of the US combat arm.

It was the development of the active defense doctrine that constituted the major shift in US tactics. Heretofore, US defensive tactics allowed for the intentional giving up of terrain under the mobile defense concept. The active defense concept changed this, allowing that terrain would only be given up begrudgingly, and then efforts would be made to regain lost terrain deemed critical to the conduct of the defense. Two major considerations lay at the heart of the active defense:

(1) That the commander would have sufficient intelligence at his disposal to allow him to "see the battlefield" and thus determine where the enemy main thrust would be directed. This would allow the commander to shift forces from less threatened areas to block, disrupt and destroy the main enemy attack.

(2) Through the careful selection of terrain following extensive terrain analysis, position available tanks and ATGMs to destroy advancing armor at the maximum possible distance, thus reducing the enemy's fighting effectiveness.

The tactical commander would employ all the intelligence-gathering means at his disposal, assess the resultant information, and determine the enemy's plan of attack in sufficient time that he could take countermeasures to blunt the pending thrust. He would take every measure at his disposal to prevent being outnumbered more than three to one in terms of equivalent combat power of the point of decision on the battlefield. Capitalizing on his mobility and firepower, the commander would then attempt to deploy his combat power as far forward as possible, subsequently repositioning those forces during the course of the coming battle to achieve depth through-

out the defensive sector. Obstacles would then be positioned to enhance the capabilities of the defending weapon systems; field artillery fires would be massed to disrupt the attacker and strip away his infantry; tactical air support would be concentrated against the massed main enemy effort; electronic warfare resources would be used to disrupt enemy command and control nets, and to intercept communications; and ground and helicopter mounted antitank guided missiles would be employed to destroy and disrupt the attacking force before the enemy can bring the full weight of his force to bear.

While it would be the division commander that would plan the conduct of the defense, it would be the company team that would have to execute that plan. An integrated system of tanks and ATGMs supported by artillery and engineers would be the mainstay of the active defense. It would be the TOW with its 3,000 meter range that would become a critical element in the defensive equation. Placed in an overwatch position, the TOW would engage the leading armored vehicles, and continue to engage until tanks in defensive positions could enter the battle. TOWs positioned in depth in concert with the tanks would continue to destroy advancing tanks and armored personnel carriers. As the enemy advance would close to within 1,000 meters of the defensive position, the medium-range DRAGON ATGM would enter the battle. While the company team would focus its attention on but a single portion of the attacking force, it would be working in concert with combined arms teams along the breath of the attack.

The tactic just described is the driving force behind the active defense, which is the backbone of the current US defensive doctrine. In theory it sounds great--providing the battle was fought on terrain that allowed uninterrupted long-range observation, without the confusion of smoke, incoming rounds and excessive targets to contend with. A mechanized-infantry company has two TOWs (plus augmentation of either direct or general support TOW teams), nine DRAGONS, and as many light antitank weapons as necessary in addition to whatever tanks might be allocated for that defensive sector. The company team would have to contend with at least 60 to 80 tanks and armored personnel carriers, the latter armed with SAGGER ATGMs.[6] It becomes the mission of the company team to service these attacking armored vehicles in conjunction with the other elements of the combined arms team. Excessive targets and the confusion of battle now becomes the problem. I wish to continue with this thought, but before I do, it is necessary to take a quick look at current Soviet offensive tactics, since an appraisal of enemy tactics will allow us to better assess our own.

SOVIET OFFENSIVE TACTICAL DOCTRINE

Todays Soviet offensive doctrine remains virtually unchanged from when it was developed during what the Soviets call "The Great Patriotic War," 1941-1945. It was during the closing years of the war, late 1943 to the war's end in 1945, that the Soviets hit upon the combination of massed men, tanks and artillery to stop the Germans and eventually destroy them. From 1945 to the present, the Soviets have retained the tactic of massed combined arms, and have simply refined the tactical art and

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[6]Based on the organic armor of an attacking Motorized-Rifle Regiment, with estimated early losses, etc., considered.

added more numbers to the material mass. Combined arms and massed firepower are the two principle fundamentals of the Soviet tactical offensive doctrine. Added to these (not in any order of priority) are the fundamentals of speed, maneuver, attack by echelon, use of reconnaissance to achieve security and surprise, and continuous offensive operations. Inherent in continuous operations is the fundamental of bypassing built-up areas and strong points. While the manner of the attack relative to time and place may vary, it is certain that any attack will incorporate these fundamentals.

Western analysts may disagree as to the extent of early warning that will be forthcoming, but most agree that the attack will be spearheaded by massed motorized rifle units to achieve the desired breakthrough, followed by massed tank forces exploiting the success, and striking well into the NATO rear. It is my own assessment that an attack against Western Europe will look something like this--the Soviets will spearhead offensive operations, attacking along a broad front, and leading with motorized rifle units, while airborne teams operate in the NATO rear to seize key communication points and disrupt command and control facilities.[7] The attack in the center against US forces will be designed to hold those forces in place, and if momentum is achieved, attack to seize crossings over the Rhine River, isolating the city of Frankfurt. The main attack will probably be directed against the weak Dutch and Belgium Corps in the North German Plain, with Soviet forces

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[7]While this scenario was arrived at independently, it is supported by many NATO intelligence analysts, and has been officially put forth in a major concept paper entitled "Europe Without Defense? 48 Hours That Could Change the World" by MG Robert Close, Arts and Vouages, Brussels, 1976.

attempting to gain a foothold west of the Rhine River, and thus sever NATO lines of communications and drive a wedge between NATO forces. It is highly probable that the attack in the north will be supported by an attack in the south through the Danube Gap. However, any of the three thrusts that might enjoy success could quickly become the main effort.

In compliance with their doctrine of bypass, continuous operations, and maintaining the momentum (speed), the Soviets and their Warsaw Pact allies will make every effort to bypass resistence, and leave that bypassed force to the second echelon forces to contend with.

The tactical thrust just described in nothing more than analytical judgement, but the offensive tactics described are very real. It is these that must be successfully countered if we are to be effective. However, what does the generalities of Soviet offensive doctrine have to do with the specifics of effectiveness of the antitank guided missile employment tactic in the active defense? To best answer this question, we should look at the ATGM system in the defense relative to the Soviet offensive tactics:

(1) Combined arms formations: This presents a problem of <u>target selection</u>. Does the ATGM engage the attacking armored fighting vehicle BMP with its 73mm main gun and SAGGER ATGM, or the medium tank that fires the world's fastest round with great accuracy and lethality?

(2) Massed firepower: The mass of attacking weapons systems will present a considerable problem of being able to effectively <u>service the numerous targets</u>. The Soviets employ the principle of mass to overwhelm the opposing enemy. Soviet military writers readily recognize the importance of mass in the execution of their combat tactics:

> "On the basis of theoretical studies and the law of concentration of forces it can safely be said that, committed to action simultaneously, 20 tanks can effectively and swiftly deal with 10 similar tanks. At the same time, if these 20 tanks are committed to action piecemeal, in twos and threes, the 10 tanks fighting simultaneously are quite likely to win. Success in combat, therefore, depends not only on the total number of antitank weapons, but also on the ability to commit simultaneously to action the right number of these weapons against a definite number of enemy tanks."[8]

It is interesting to note that not only does this writer address the significance of mass, but also addresses a perceived tactical countermeasure for defeating massed armor.

(3) Attack by echelon: Even if we are able to destroy the lead echelon of an attacking force, we will then be faced with the successive attack by the second echelon. This means ATGM crews will be faced with weapons depletion through exhaustion of ammunition and systems destruction. Thus less ATGMs (and tanks) will be available to service still more targets.

(4) Maneuver/bypass: Even if we effectively position our defensive weapon systems, once the enemy knows their positions, he will attempt to fix our force, and maneuver or bypass the main resistence, thus removing a potential target from the target window. If the attacking force is successful in his maneuver, then the ATGM will have no target to service in that particular battle area. The resultant shift in enemy forces may very well overload another defensive position less capable of defending unless blocking forces can be quickly moved into position.

An integral element of each Soviet offensive principle is the fires that are delivered by the attacking forces which results in system destruction, suppression and confusion in general.

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[8]Biryukov and Melnikov, op. cit., p. 98.

Taking a one-sided look as we just have was not done to negate the tactical value of the TOW ATGM system, but to merely point out some of the problem areas that a TOW gunner would be confronted with. The antitank guided missile crew is but a single ingredient in the combined arms team, and as such will be but a single system along with many others that will be directed against the enemy in an effort to destroy or discourage the continuation of the attack. The problems that have been discussed relative to the ATGM can also be attributed to any other weapons system on the battlefield. What is different is that a great deal of emphasis has been placed on the TOWs ability to reach out and destroy armored vehicles to 3,000 meters, and much of the tactical defensive thinking by combat commanders is influenced by this single capability of the TOW system. Furthermore, NATO perceives any future attack in Central Europe as being one of massed armored vehicles initially attacking in a conventional battle. This is further reinforced by an apparent shift in Soviet thinking that any future European war might begin and may even remain conventional. Even though the Soviets have long held 31 maneuver divisions in the Forward Area, this shift in attitude is evidenced by the forward positioning of large stocks of ammunition and the construction of new forward underground fuel lines. To make matters still worse, the Soviets are continuing to deploy new and increased numbers of tanks and artillery to the forward deployed divisions.

There are numerous other problem areas, possibly more critical than those already mentioned, that may not allow the TOW system to be

effectively employed at 3,000 meters--or possibly even at a considerably lesser range. However, before we can fully appreciate the impact of these problem areas, it will be necessary to first gain an appreciation of the TOW system itself.

CHAPTER 2

ASSESSMENT OF THE TOW SYSTEM

The TOW ATGM is a crew-served, man-portable, heavy antitank/assault weapon designed to be employed in a ground mount, vehicle mount, or helicopter mounted configuration. It was developed during the early 1960's to replace the 106mm recoilless rifle, fielded in 1969 and has since been complemented by the medium antitank weapon DRAGON and the light antitank weapon M-72. It is currently organic to infantry, mechanized infantry, airborne, airassault and tank battalions, as well as armored cavalry squadrons.

By examining closely the technical nomenclature of the TOW, one can gain an appreciation of the system's capabilities, and be able to evaluate its limitations. The T (tube launched) O (optically tracked) W (wire-command link) guided missile system has become the principal long-range heavy antitank system in the United States Army Ground Force inventory. While its principal role is to destroy enemy armor, it can also be employed against field fortifications and emplacements. In the "ready-to-fire" mode, the system consists of five components including the missile, weighing a total of 226 pounds. While a considerable improvement over the 460 pound recoilless rifle that it replaced, its size and weight in the ground mount role still constitutes a mobility limitation. Even with its four man crew, displacement of the system is limited. To help offset this problem, the system has been

modified so that it can be accomodated by three transporters--the M-113 armored personnel carrier, the 1/2 ton mule, and the 1/4 ton truck. There are currently 3,361 M-113 APC's deployed to Europe, but not all are TOW equipped. Those that are carry ten TOW missiles, and provides the mobility and partial protection required for the system to survive on the battlefield. The XM901 Improved TOW Vehicle (ITV) is a M-113A1 APC fitted with an elevating two-launcher TOW turret which allows the missiles to be fired from hull defilade, and provides all-round armor protection to the TOW crew. The ITV will be fitted with TOW day and night sights, as well as a 2.8 power target acquisition sight. In addition to the increased protection and inherent mobility, the ITV can fire faster (two TOWs in 33-45 seconds without reloading) than the existing M-113 TOW vehicle. There is a requirement for 1,976 Improved TOW Vehicle's in Europe, but a production decision is not expected until sometime this year.[9]

The tactical two-stage BGM71A missile is launched from a tube, and has a single-type warhead--high explosive antitank or HEAT. This warhead functions on the shaped-charge principle that directs chemical energy at a single point, burning through as much as 30 inches of armor plate rather than busting through as with a kinetic energy round. Because the HEAT round is not range dependent, the missile requires only a small motor to propell it for distance rather than speed. The flight time of the missile to its maximum range of 3,000 meters will vary depending on the influence of the wire and the motor, but an average flight time is estimated to be between 14.7 and 17 seconds. Thus, if

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[9]"Army", October 1977, p. 178.

the TOW were to engage targets at its maximum range, only three missiles could be fired under optimum conditions even when considering reload time. However, field test results indicate a mean of 73.6 seconds elapse between engagements.[10] The TOW system is only limited by the number of missiles available to the gunner. If resupply of missiles is not considered, the firing capability of the system is unlimited. However, each TOW is capable of firing only one missile at any given time.

By theory, the TOW is basically a simple system to operate. It simply requires that the gunner acquire the target, track the flight of the missile through the 13-power optical sight once he has pressed the trigger, and keep the crosshairs of the sight aligned on the center of mass of the target. The wire-command link will make the necessary corrections to the flight path of the missile until point of impact. It is from this simplistic operation that the phrase "what can be seen can be hit" was derived. It is here that the basic contradiction in engagement concepts in a Central European environment prevails. Acquisition of the target in itself is not sufficient since it is necessary to be able to continue to observe or track the target to make necessary corrections to the flight of the missile. Extensive discussion will be devoted to this single characteristic further on.

The characteristic of the wire-command link is a vast improvement over the recoilless rifle since it allows the gunner to make continuous corrections to the missile simply by tracking his target. By

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[10]"TETAM Extended Analysis, Final Report," BDM Services Company, 24 December 1974, p. viii-ii

means of an infrared source, a beam of modulated energy from the missile to a sensor on the launcher allows for precision tracking and in-flight adjustments to the missiles' flight attitude. Thus, as long as the gunner is able to optically track his target, corrections will automatically be made in the missile's flight path. The ability to direct the missile is solely dependent on the length of the wire-command link--3,000 meters for the current ground mount system, and 3,750 meters for the helicopter mounted system.[11] It is the wire-command link that allows the TOW to accurately engage moving targets at ranges between 65-3,000 meters. Besides the considerable range increase (3,000 meters for the TOW versus 1,000 meters for the 106mm recoilless rifle), the TOW system has a greatly increased hit probability against a moving target throughout the flight of the missile. Barring a missile malfunction or some other deficiency in the system, the probability of hit is largely dependent on the training and ability of the gunner.

Now would seem an appropriate time to comment on system reliability. From a total of more than 1,500 firings, the TOW system had a demonstrated reliability of 99%.[12] In another test conducted by Hughes Aircraft involving a total of 243 TOW missile firings (132 missiles fired by US soldiers in Korea, 87 missiles fired by Korean

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[11]In both systems there is approximately 100 meters of additional wire that is not normally considered. The wire is lightweight--so fine in size that it scarcely has time to reach the ground before impact--of relatively high tensil strength, and insulated to prevent shorting. When the missile reaches the limit of the wire, the wire breaks, command to the missile is terminated, and the missile goes ballistic, impacting at an undetermined point.

[12]Thomas S. Velky, "Field Trials on the TOW Antitank Weapon," Hughes Aircraft Company, August 1971, p. 11.

soldiers in Korea, and 24 missiles fired by US soldiers at Fort Polk, Louisiana), only 17 malfunctions could be attributed to either the missile (five missile failures) or the launcher (12 launcher malfunctions). It is an accepted fact that the system is highly reliable. Thus, any degradation in hit probability will probably come from the degree of training capability of the gunner. In an annual service practice where each TOW gunner fired one missile for familiarization and proficiency, a total of 4,000 TOW missiles were fired with a hit probability of 89 to 90%.[13] However, the Directorate of Evaluation, U.S. Army Infantry School, Fort Benning, was quick to point out that such a finding is probably misleading since--

(1) Firing at targets 2,000-2,500 meters in a benign environment (no battlefield obscuration, etc.) increases the probability of hit.

(2) Gunners normally fired at a cooperative target--a target with a large white panel moving perpendicular to the TOW weapon at only 3-5 mph.

(3) Ranges were constructed as to allow the gunner to fire from an elevated position, thus precluding the possibility of "grounding" a missile, and maximizing observation.

(4) There appeared to be an element of gunner selection involved in order to attain the best possible results. The same tested and trained gunners were continually used to fire the TOW system.

The only reason that gunner proficiency is discussed is in order that we might look at some of the test considerations and the environ-

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[13]Directorate of Evaluation Report No. 3, "TOW System Evaluation," United States Army Infantry School, Fort Benning, GA, December 1976, pp. 73-74.

ment under which the tests were conducted so we might compare these further on with more realistic combat conditions. Furthermore, it is from the results of such tests that commanders have become conditioned relative to the TOW system range, high hit probability, and equally high kill probability.

Now that we have examined the capabilities of the TOW system, let us now examine some of the limitations as apply only to the system itself. Tactical limitations will play a key role in this study, and will be discussed in the next chapter.

Because of possible eye damage to the gunner and interference with the guidance system as a result of the glare, the TOW cannot be fired directly into the sun. The only time this condition might prevail would be during periods of sunrise or sunset, with the sun immediately to the rear of the target. Considering that NATO forces will be initially on the defense, and facing east, an early morning attack could possibly allow for a temporary degradation in the TOWs capability. However, this is rather remote considering any angle between the line of the sun and the gunners line of sight greater than six degrees degrades the glare of the sun and its influence on the optics sufficiently that it is considered to be no longer a limiting factor.

The effect of cross winds may cause some degradation in the hit probability due to the winds influence on the missiles' control surfaces. This is especially true in gusty winds. The greater the range of engagement, the greater the chance of the missile being blown off course. This limitation is largely offset by the command-link that corrects the

flight of the missile. It should be noted that as the wire link plays out, the missile becomes lighter, and thus more susceptible to the influence of winds.

Tests conducted in extremely cold weather environments indicate a potential problem of a formation of ice (ice fog) that forms out to a range of 500 meters as the flight motor burns. Since these extremes of temperature (-20 degrees F and below) are rare in Central Europe, this limiting factor affecting the gunner's capability to track the missile is not considered to have an influence on the discussion.

Since the TOW system is an open breech weapon, it has a resultant back blast area creating a weapons signature and a danger area. The back blast area extends 75 meters to the rear of the launcher and forms a conical danger area to persons standing to the rear. As a result, the TOW missile should not be fired from an enclosed space or an area that might cause excessive flying debris. Firing from a confined space such as a dugout or from a room of a building could cause severe concussion, a concentration of toxic gases, or fire. Furthermore, this back blast effect has caused a firing angle limitation of 20 degrees elevation to be imposed. As the elevation of the launcher increases, there is a corresponding degradation in system accuracy. Ground clearance in the ground mounted mode of 28 inches must be maintained to insure loading and tracking.[14] The limitation in the degrees of elevation and the requirement for ground clearance may drastically reduce the ability to employ the system on a reverse slope, and requires a higher than desired silhouette.

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[14]The Hughes Aircraft Company recommends a ground clearance of 36 inches.

It should be noted that, while the number of antitank systems has been increased in Europe several times over, the maintenance capability has not kept pace.[15] The Hughes Aircraft Company is currently producing 3,500 missiles ($3,304 per unit) and 225 launchers ($27,334 per unit).[16] There will be an estimated 134,249 TOWs produced by the end of 1980. Large quantities of TOW systems are necessary, but this generates the added problem of one system competing with another for maintenance service.

The capabilities that have been covered indicates a high degree of system reliability and accuracy. The limitations discussed thus far have been of a technical nature, and serve to point out that the technical characteristics of the TOW system will influence the placement of the weapon. When we discuss the tactical environment and the added limitations imposed by combat, we can better derive a clearer understanding as to where the main battle may be fought.

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[15] USAREUR Message 051937Z Jan 76.

[16] "Army", October 1977, p. 154.

CHAPTER 3

TOW ENGAGEMENT IN THE ACTIVE DEFENSE -- 3,000 METERS OR LESS?

Environmental Considerations

It's a cold clear December day in the vicinity of Alsfeld, West Germany. The enemy has already crossed the demarkation line, and your unit has moved into its defensive positions within the main battle area. Obstacles have been emplaced, positions improved and camouflaged, and range cards checked. You are positioned high on commanding terrain. In the crisp December daylight your tank and antitank gunners can see virtually "forever". Dead space in the fields of fire have been covered by obstacles and planned artillery fires. You and your men patiently wait for the attack you know is coming. You wait. Hours pass and the sun sinks to the rear of your position, taking with it what warmth it provided. With what light of day is left, you strain your eyes across the rolling farmland to your front to find evidence of the expected attack. But no attack comes. You pass the word to your men to stay alert. Darkness closes in, and the men become more concerned with keeping warm. Hours slip by. What had started simply as a light snowfall shortly after midnight has now turned into a blinding snowstorm. You strain to hear through the blowing wind. In the distance you can hear the sound of battle as the covering force takes its toll of the probing enemy. The black of night gives way to gray as morning approaches.

Part of the covering force has already passed through your forward positions. Word has been passed that a large enemy mechanized force is following close behind. Adrenalin flow brings everyone to full alert, and they strain to see through the driving snow and low overcast to see any traces of the lead attacking elements. Suddenly your position erupts from incoming artillery. Mixed with the gray snow is spreading smoke that covers your position. The explosions last what seems like hours, but finally the barrage lifts. Again your ears strain through the howling blinding snow. You can hear the clanking of tracks and the screams of men an estimated 400 meters to your front. Suddenly so close! "TOW gunners! Select your targets! Fire at will!" No TOW gunner fires. Certainly you are aware that one TOW had been destroyed during the enemy preparation, but your one other organic TOW and the three other TOW's in direct support to your sector are still functioning and well placed. Still, no TOW gunner fires. You can hear the armored vehicles now at 200 meters to your front, but the combination of wind-blown snow, smoke and haze prevents you or your TOW gunners from seeing the intended targets. You know they are there. If only you could see them. If only you could bring them under fire by your TOW's or tanks. If only they had attacked yesterday when you could see almost "forever".

Later, a survivor of this company team that had defended so well in hand-to-hand combat before being forced to withdraw remarked, "We couldn't see them until they were right on top of us. If only they had attacked yesterday!"

Why do we think it likely that an enemy will attack at a time or place that is most favorable to the defender rather than himself? For the few planners that engage in wishful thinking, this may be the case, but this is certainly not true of the average pragmatic tactical commander. One would think that we would prepare for combat under the worse conditions as this preceeding vignette has depicted. The fact remains that most of our systems, and specifically the TOW ATGM system, are currently designed primarily for daylight visibility in clear weather. The Soviets readily recognize the limitations of existing US antitank systems, and the corresponding weakness inherent in our antitank defense. The Soviets view the antitank defense in the following manner:

> "The combat potentialities of any antitank weapon are, of course, determined by its characteristics, namely, armor-piercing ability, fire accuracy, rate of fire, range and protection. They depend on the quantity of antitank weapons, the morale and fighting efficiency of the personnel, on the weapons, tactics, morale and fighting efficiency of the enemy, on the co-operation with other forces and weapons taking part in the given battle, THE NATURE OF THE TERRAIN, WEATHER, TIME OF THE DAY AND SEASON (capitalization for emphasis)."[17]

The nature of the terrain, weather, time of day and season, and add to this the technical limitations of the weapons system and the Soviet propensity to assault using mass, and you have a combination that adds up to a major deficiency in our antitank defensive doctrine for Central Europe. This deficiency is expressed in terms of diminished intervisibility, or the ability to see continuously from point A to

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[17] G. Biryukov and G. Melnikov, Antitank Warfare, Progress Publishers, Moscow, 1972.

point B. We can best determine the extent of the deficiency by analyzing each of the factors that contribute to it.

THE NATURE OF THE TERRAIN

When assigned a mission to defend, a good tactical commander will immediately analyze his defensive sector relative to the terrain--positions that provide long range observation and fields of fire, probable enemy approaches into the sector, areas that cannot be covered by direct fire weapons, areas that provide cover and concealment to both friendly as well as enemy forces, key terrain that, if held, provides a decided advantage, and any natural or manmade area that would constitute an obstacle to movement. The terrain analysis would first be conducted from a map, but using a map alone would be very risky as terrain can be changed by construction or natural growth. Reforestation programs and natural vegetation growth account for an average annual increase in forested areas in the FRG of up to three to five percent. This rather obvious factor plus the realization that knowledge of the terrain gives the defender the advantage would cause the commander to conduct a terrain reconnaissance. Thus the commander, his officers, and his key non-commissioned officers would walk the terrain to gain a first-hand appreciation of the lay of the land.

NATO forces are extremely fortunate in that commanders have ready access to the terrain which they are tasked to defend. Every fold, every interruption to the line of sight, and every piece of high ground has been thoroughly assessed on the ground. NATO commanders are afforded the luxury of conducting terrain walks, sometimes occupying intended positions during the course of their field training, and becoming totally familiar

with the defensive sector. Conversely, commanders of the Warsaw Pact will have the disadvantage of attacking over unfamiliar terrain. Granted, they too will have conducted a map analysis, but for the reasons previously mentioned, this is not sufficient. Furthermore, in the case of the Soviets, there is only one map available at the motorized-rifle (or tank) company level. That one map is closely held by the company commander since it is a classified document. This restriction limits the extent to which subordinates can conduct a map analysis as compared to the NATO counterparts.

The attacking force commander would be able to make some general determinations from his map assessment as well as geodetic and demographic studies. In analyzing the US V Corps area that sits astride the central approaches into the Federal Republic of Germany, he would see that the sector contains the Knullgebirge mountains in the north, the Vogelsberg mountains in the center, and the Hohe Rhon and Spessart mountains in the south (See Figure 2). These dominant rugged, hilly and mountainous land-forms that make up the German Central Highlands would also restrict the movement of his highly mobile force in addition to restricting his long range observation. These land-forms range from mountainous terrain to low valleys. Additionally, most of the terrain is heavily forested except for those areas specifically designated for agricultural development. Even the farm lands are segmented by linear treelines and natural growth. Most of the forest trees are coniferous (evergreen) or deciduous, or a combination of the two. The stands of coniferous trees reach as high as 80 feet, are usually regularly spaced approximately ten feet apart, and are periodically pruned up to ten feet

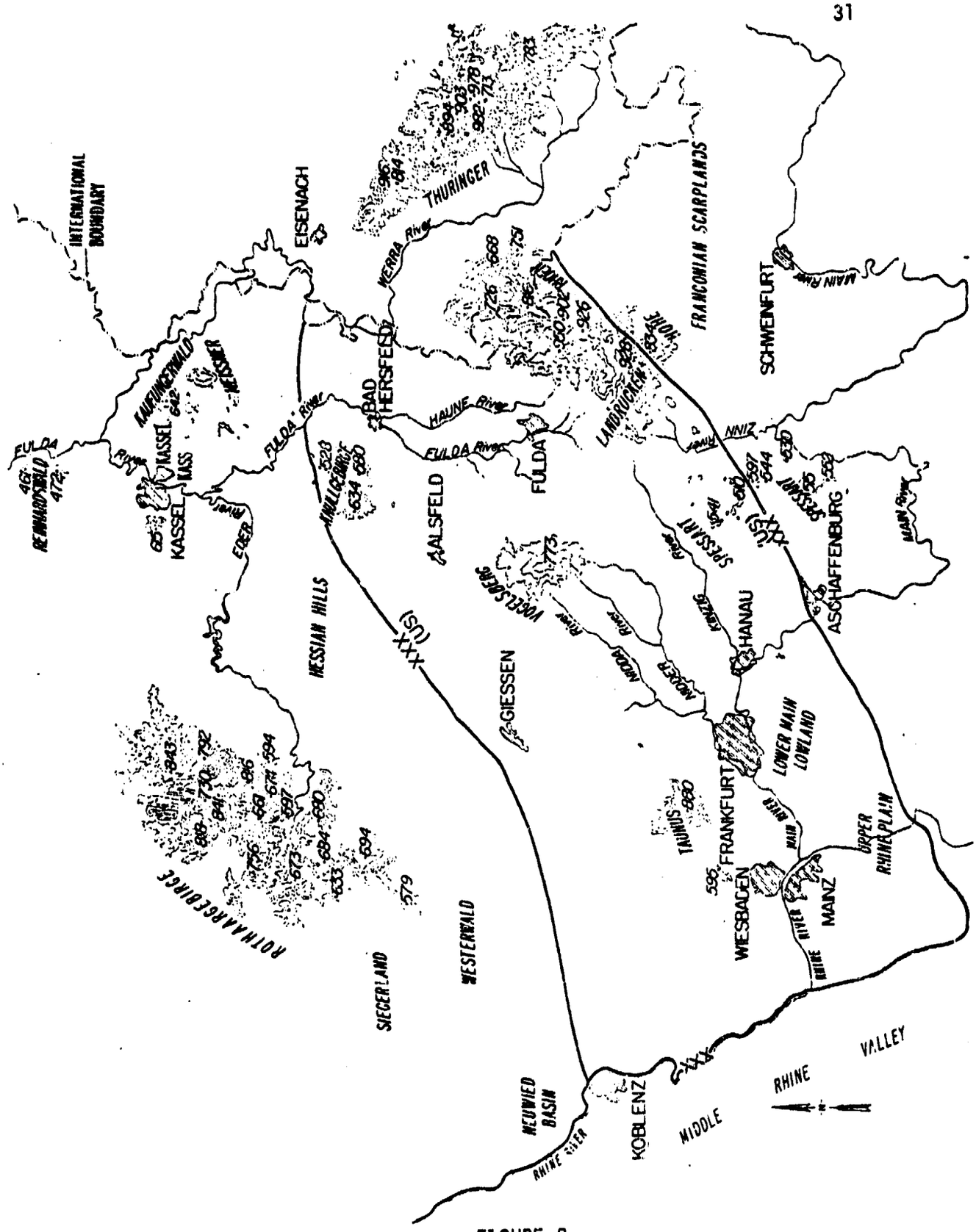

FIGURE 2

Terrain Relative to the US V Corps Defensive Sector

from the ground. The deciduous stands range from 20 to 100 feet high, and are irregularly spaced. The reforestation program has resulted in a growing expansion of blocks of trees separated by access lanes. These access lanes provide rather obvious routes for movement, but at the same time tend to canalize movement, and make excellent antitank fields of fire.

The few valleys that form the natural corridors for movement within the area (such as the Fulda Gap) are dotted with a dense pattern of built-up areas ranging from small villages to major cities. Populated or built-up areas are increasing in size and number as the population increases. The Federal Republic of Germany ranks third in population density behind the Netherlands and Belgium. The FRG currently has an average of 239 inhabitants per square kilometer as compared to 23 in the United States. A demographic distribution by region is shown at Figure 3.

Where you find people, you will find buildings of various sorts. The resultant population density has resulted in an urban sprawl that is overtaking the FRG. West German studies show that the average brigade sector in Western Europe encompasses 25 towns with populations up to 3,000.[18] An analysis of urban areas in Central Europe is very revealing in terms of intervisibility. Built-up areas in the US V Corps sector fall into four different categories:

1. Villages: a cluster of houses, barns, stores and churches, and having a population of 1,000 inhabitants or less.

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[18]"Federal Republic of Germany Special Training Manual for Combat Troops," Nr. 3/76/1976, p. 5.

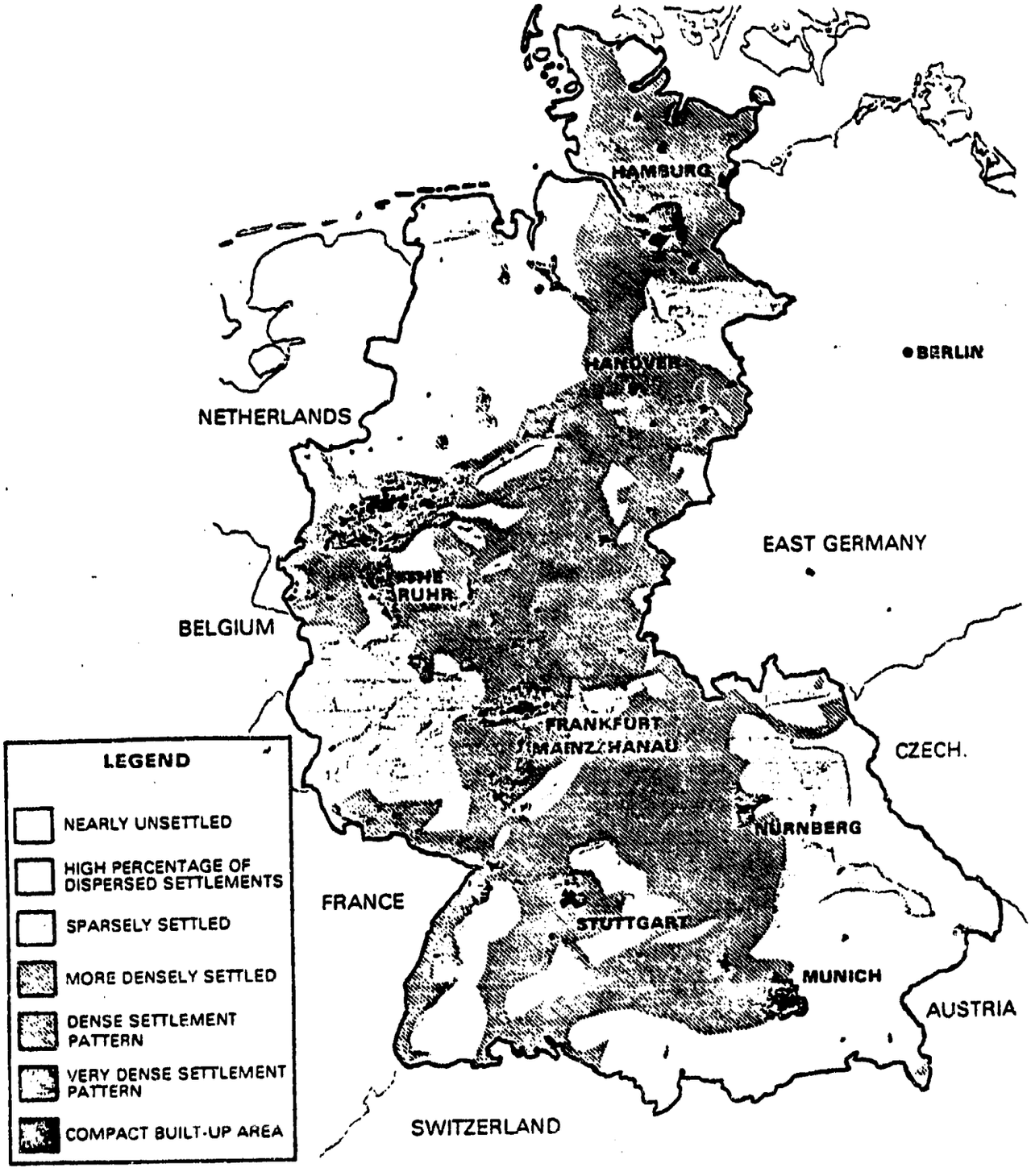

FIGURE 3

Nature of built-up area development in West Germany

2. Strip areas: usually a linear configuration of houses, stores and factories that follow valleys or connecting roads between towns or villages.

3. Towns and small cities: those areas with a population base of up to 100,000, but not a part of a major urban area. Some of the towns on the forward trace of the main battle area of the US V Corps sector would fall into this category.

4. Large cities: those areas associated with urban sprawl, having an area of 100 square miles or more, and a population base numbering in the millions. The cities of Giessen, Wiesbaden, Mainz and Frankfurt in particular would fall into this category.

Why this discourse on man-made areas? Obviously, built-up areas present an obstacle to movement, and tend to canalize movement into predictable avenues of approach and field of fire. An equally important consideration is that buildings must be viewed in the same light as natural terrain--having elevation, density, providing all the tactical advantages and disadvantages normally associated with terrain, but most important, buildings can and do disrupt line-of-sight.

In the rural areas of the corps sector where the main battle would be fought, the agricultural countryside is surprisingly regular with villages and surrounding woods usually spaced some 1,500 to 2,000 meters apart. The momentum of the attacker would be slowed to the extent that these closely spaced villages and woods would create an obstacle. It must be considered that what is an obstacle to movement may very well be an obstacle to target acquisition and engagement.

INTERVISIBILITY

Some aspects of the discussion concerning terrain may appear to be lacking, and intervisibility was not one of the major topics for discussion as defined by the Soviets. Why intervisibility? When discussing the impact of terrain on antitank engagement, as well as the influence of time of day, weather and season, all must be discussed in terms of the restrictions they impose on the effective employment of the weapons system. Intervisibility, or the ability to see between two points on a line-of-sight, is the single greatest influence on any flat (or relatively flat) trajectory weapon system. Simply put, if you can't see your target, you can't hit it with any predictable degree of accuracy. Natural or man-made "terrain", with its elevation, turns and density, will disrupt line-of-sight in varying degrees. Only on a piece of terrain that is totally flat and without vegetation can there be uninterrupted observation. Nowhere in Germany can such terrain be found. Even the relatively flat North German Plains are broken by vegetation, waterways, and rolling farmland. The influence of natural and man-made "terrain" on line-of-sight observation is depicted in Figure 4.

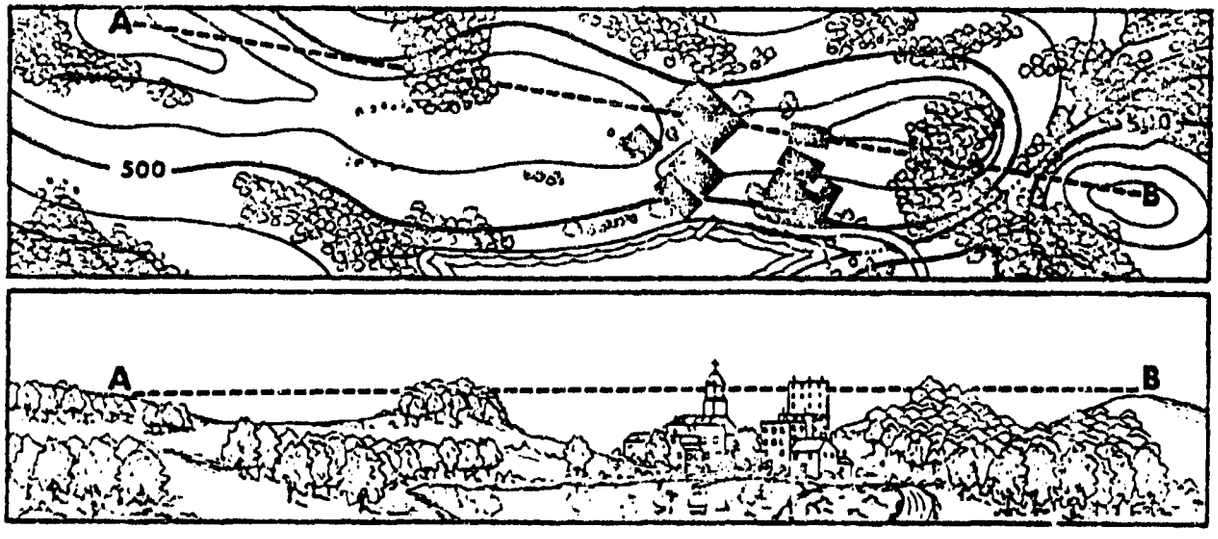

FIGURE 4

In an effort to assess the extent to which intervisibility played a restrictive role on the employment of the TOW ATGM system, I conducted a personal terrain walk of the US V Corps sector, limiting the forward extent of the evaluation to that area immediately forward of the probable forward trace of the main defensive area, and that area as far back as Frankfurt. The terrain assessment was conducted during the month of September, 1977, a month normally considered to be optimum from a weather standpoint. Every effort was made to remain as objective as possible, with stops made randomly at five minute intervals rather than at predetermined locations. In virtually every case, an effort was made once a stop took place to get into a position that would maximize line-of-sight observation rather than restrict it. Mentally the eye became the TOW sight, and a concerted effort was made to search for a position in the immediate area that would provide for the optimum tactical engagement. The conclusions that can be drawn from the terrain walk are these:

1. Normally, the only place that line-of-sight observation exceeded 2,000 meters was on terrain overlooking a basin (or valley) looking from an elevated vantage point to an elevated clearing. Such terrain would maximize the TOW system capabilities as assessed in the TOW System Evaluation DEV Report, but such locations were few. In many cases where such terrain could be found, high tension wires bisected the terrain. A TOW ATGM firing over these wires would have the control wires severed the instant the wires were to settle on the power lines. This problem could be easily overcome simply by cutting the wires or

setting demolition charges to the towers. However, such a move would have an immediate energy impact on the surrounding area, and would carry with it political implications. The problem will probably be solved before the defending force is faced with the decision of how to correct the problem since enemy incoming artillery would most likely destroy the power lines that would create a hinderance.

2. Fields of fire down primary (autobahns) and secondary (schnellstrasse) roadways were limited usually to a maximum of 700 meters due to elevation folds or turns in the road. Considering the restrictions imposed by the forested and built-up areas, road systems would be a likely avenue of approach for the highly mechanized forces of the Warsaw Pact that would be searching for and using multiple attack routes. This is not to imply that the autobahns and other roadways would be the only routes that the attacking force would use, but is to say that when used, these road networks would restrict long-range line-of-sight.

3. Natural terrain density usually limited visibility to a maximum observation out to 2,000 meters, and even then there were numerous depressions and tree lines behind which attacking armored forces could conceal themselves. For example, even if a likely avenue of approach could be observed at 3,000 meters, a target selected, and the missile fired, by the time the missile was halfway to the point of contact, the target could lose itself in a depression or behind a line of trees, disallowing the gunner to continuously track the intended target. For that matter, a target could appear, disappear again behind concealment, and reappear again many times while traversing the 3,000 meter range.

4. Firing from vegetated areas would require clearing fields of fire, thus presenting the possibility of exposing the system to a thorough reconnaissance. Hazards created by the back-blast would also be magnified when firing from a forested area. The back-blast would also interrupt any emplaced camouflage, which is often necessary for TOW concealment.

It was my personal observation that the ability to effectively emplace TOW systems in the defense at 3,000 meters, or even in excess of 1,500 meters would be very limited. This observation is supported in particular by the "US/GE Antiarmor Concept Paper" published by the German Army staff on 15 November 1976. This paper concluded, following extensive terrain studies of Central Europe relative to intervisibility, that the lead enemy tanks conducting the attack would be first observed at the following ranges:

Less than 2,000 meters:	70-80%
2,000-3,000 meters:	10-20%
Greater than 3,000 meters:	5-15%

This conclusion is further supported by a Canadian-United Kingdom-United States study published on 12 August 1976 entitled "Terrain Shielding Models Working Group." Contained in this study is an inclusive work written by Dr. David C. Hardison, Under Secretary of Defense, dealing with line-of-sight distances in Europe. Dr. Hardison presented an interesting observation stemming from analysis of tank casualty ranges in Central Europe during World War II. Based on available data, and with the knowledge that the Germans employed antitank weapons with an effective

range of 3,000 meters, the historical analysis concluded that the German AT guns destroyed US tanks at ranges only slightly greater in distance than did the US tanks and AT guns shooting at German tanks. Ninety percent of US tank casualties were taken at ranges of 1,650 meters or less, while German tank casualties suffered ninety percent losses at ranges of 1,550 meters or less--a variance of only 100 meters. Dr. Hardison concluded that:

> "It thus seemed at the time that the tank casualty ranges were governed mainly not by weapons characteristics but rather by the distances between successive features capable of providing concealment/cover to the tank--i.e., of obstacles which interrupted line-of-sight."[19]

Thirty-three years have passed since the last combat in Central Europe. Given the increases in natural growth and urban sprawl that have occurred during this time, it must be concluded that restrictions in line-of-sight pose even a greater problem now than then. As if to anticipate the propensity of today's commanders to measure line-of-sight along the distances that affords the greatest field of observation, Dr. Hardison suggests that the attacker (based on WWII data) will use routes which provide the greater protection rather than random paths which afford ease of movement. With this consideration in mind the net results regarding line-of-sight in Central Europe are shown in Figure 5:

Description	Range (Meters) Below Which Indicated Percent Occurred		
	50%	90%	99%
Distance of First Cut-off of Line-of-sight Measured from Defensive Firing Positions in Random Directions within Sector	1200	2800	4200

[19]David C. Hardison, "Line-of-sight Distances," 12 August 1976, pp. 9-10.

(Figure 5 Continued)

Description	Range (Meters) Below Which Indicated Percent Occurred		
	50%	90%	99%
Distance to First Cut-off of Line-of-sight Measured from Defensive Firing Position in the Direction of Actual Attack	850	1975	3400

FIGURE 5

Comparison of Los Distances - Random Direction and Attack Direction

The conclusion that can be drawn from this significant variance in ranges is that there is an interaction between terrain and tactics that cannot be ignored even in view of the weapons characteristics.

The British are quick to appreciate this interaction between terrain and tactics. Even in the conduct of the defense by the British in the North German Plain, an area superior to that of the US V Corps in terms of intervisibility, the British expect the effective engagement range to be restricted due to interruptions in line-of-sight. Current British doctrinal writings, supported by studies of terrain and relative intervisibility, state:

> "The powerful and very accurate high velocity 120mm gun can hit and kill enemy tanks at ranges over 3,000 meters in ideal conditions, but such engagements will only occur in exceptional circumstances, e.g., from temporary 'sniping' positions. The maximum range of Chieften in normal circumstances is taken as 2,000 meters for tank versus tank engagements."[20]

This same British doctrine calls for engagement to begin at the maximum effective range of the main tanks guns (2,000 meters). Certainly antitank weapons will engage targets at greater ranges where possible,

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[20]British Staff College, Combat Arms 1, Annex B, "The Armored Regiment," 1978, p. B-4.

but the British doctrine estimates the greatest effectiveness will be gained once the antitank systems enter the battle in concert with the tank defensive fires. The fact remains that the problem of intervisibility is recognized to adversely influence weapons engagement range is expected to take place at 2,000 meters or less. This is a clear example of tactical reality overshadowing weapons capabilities.

Not all major US field commanders seem to be impressed with the doctrinal employment of the TOW system out to 3,000 meters in Central Europe. On 4 January 1978, in an address to the students and faculty of the Command and General Staff College, Fort Leavenworth, Kansas, Major General R. Dean Tice, Commanding General of the 3rd Infantry Division, stated that the engagement range of the TOW in Central Europe would be between 800 to 1,000 meters. He further went on to state that anyone believing the engagement range of the TOW would be 3,000 meters was not in touch with reality. In accepting this statement, it is safe to assume this evaluation stems from judgement based on an assessment of the terrain, the TOW system and knowledge of the enemy tactics.

WEATHER AND SEASON

More than just terrain influences intervisibility in Central Europe. Daily weather conditions and seasonal conditions also play a major role in limiting the extent of visibility.

For those troop leaders that have been to Central Europe, or for those that understand that prevailing conditions of weather and terrain override the characteristics of a weapons system, there appears to be an understanding of the limitations that might be imposed on the

TOW system resulting in reduced visibility brought about by diminished weather conditions. This short paragraph published in the November-December, 1977, issue of Infantry best sums up the conditions that largely prevail in Central Europe: "Weather conditions in Central Europe change quickly and defensive plans that were logical for good visibility become totally illogical as the visibility decreases to a few meters."[21]

During daylight hours in conditions of clear visibility the TOW can often do the job of engaging at 3,000 meters providing vantage points on terrain have been properly selected and no obstacles prevent uninterrupted line-of-sight. Thus the doctrine presented in the "How to Fight" manuals, and specifically FM 100-5 "Operations," is an accurate depiction of the tactics that could best prevail on the modern battlefield. However, daylight hours would be available to the defender only about two-thirds the time during the course of a 24-hour period, and weather conditions (predominately fog) would influence visibility conditions for up to one-third of the daylight hours for an estimated four months out of the year (See Figure 6). Periods of greatly reduced visibility--down to 500 meters or less--are common in Central Europe, and pose the greatest environmental problem to TOW employment. The TOW may be suitably emplaced to maximize its range, but once fog or other weather conditions set in, its capability is greatly reduced. Thus, the combat effectiveness of the TWO system may diminish to that of a light antitank weapon having only a few hundred meters range. Without the ability to see at night or through fog, smoke, haze, snow or rain, the long range engagement capability of the TOW is reduced well in excess of 60 percent.

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[21] "Defense on Extended Frontages," MG P. W. Crizer, Infantry, Nov-Dec, 1977, p. 20.

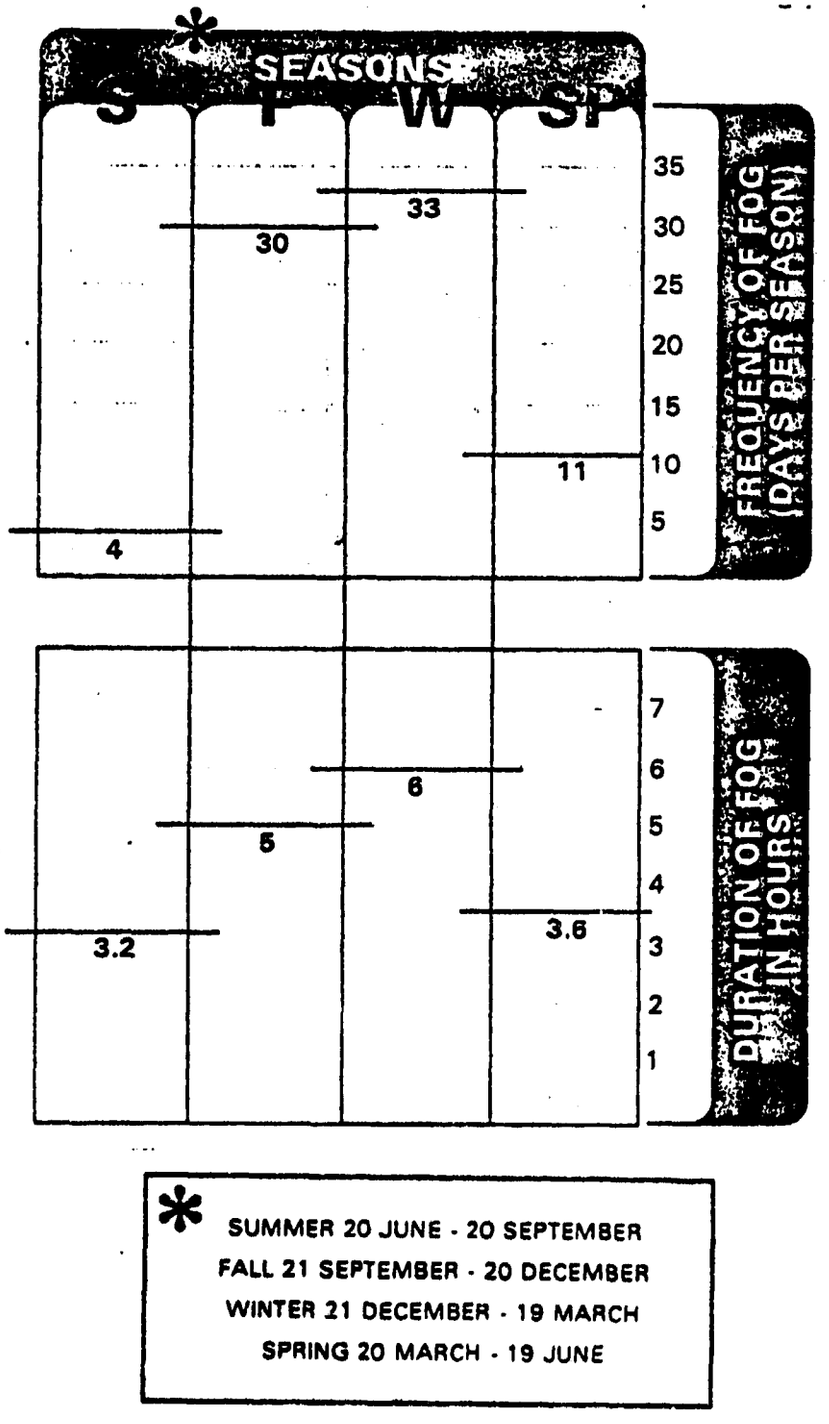

FIGURE 6

Frequency and Duration of Fog in West Germany

To what extent can we expect weather conditions in Central Europe to influence the antitank tactics in the active defense? We can best determine the answer to this question by assessing the climatic evaluation for the region.[22]

Maritime air masses, which are more frequent in winter than other air masses, dominate the area of operations on an average of ten to twenty days per month, often without interruption. Generally speaking, winter is cloudy and frequently stormy, with moderate temperatures; summer is somewhat less cloudy and comparatively cool. Rainfall is heaviest in summer, and relative humidity tends to be very high. Winter is the season for the highest relative humidity, ranging from 70 to 80 percent. Surface winds influence the area, with the low-level airflow that blows over the area most often coming from a westerly direction. Precipitation amounts to eight to twelve inches during the three summer months. While the precipitation diminishes as the season gives way to autumn, the fog increases. Fog is the primary cause of restrictions to visibility, with natural and industrial smoke and haze restricting visibility, to a lesser degree. Fog in Central Europe has a marked seasonal pattern. Throughout the year, particularly in the areas with greater elevation variances, considerable local variation in the fog density can take place within short distances. In all seasons, visibility is usually at a minimum just before, at, or a little after sunrise.

Most of the fog is radiation fog, and as such, is generally at a maximum near sunrise during the winter season. Central Europe, with

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[22]The discussion relative to weather and season is drawn heavily from weather studies supporting "Forward Deployed Force Operations (European Setting)" and FM 100-5.

its relatively high latitude, has rather long nights in late autumn and winter. This provides the necessary radiational cooling to lower visibilities to less than 2½ miles rather frequently. Visibility is reduced below 2½ miles between 20 to 50 percent of the time at lower elevations, and more frequently in cloud-enshrouded higher elevations.

During summer, fog frequency is quite low and generally confined to hours around sunrise. Summer months provide less visibility restrictions from fog, with hinderance stemming from fog occurring only two to ten percent of the time in summer. Conditions are even more improved in the sping, with reduced visibility caused by fog occurring only two to five percent of the time. Autumn, particularly late October and November, is the most foggy time of the year, although not necessarily the period of poorest visibility. Many of the characteristics of winter fog also apply to autumn; however, an additional consideration is the lighter winds that permit increased fog from radiational cooling at night. Late autumn accounts for the greatest daily variation in low visibility experienced any time during the year, with most of the poor visibility occurring within an hour or two of sunrise. Field Manual 100-5 has this to say about fog and its effects:[23]

"Fall, winter and early spring are featured by frequent fog which lies heavily on the land and often does not lift until midday. Frequency and duration of morning fog are depicted in Figure 6.

The same discussion continues by stating:

> "Approximately one out of three mornings during the fall and winter, US forces will have less than one kilometer visibility causing a significant reduction in the frequency of long range engagements."

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[23]FM 100-5 "Operations," p. 13-11.

Many of the current U.S. "How to Fight" manuals readily recognize the environmental considerations relative to TOW employment in Central Europe. However, it would seem that the writings and assessments merely pay lip-service to the problem of restricted intervisibility. The conclusions that are drawn from U.S. tactical writings are:

1. Due to hills, valleys, vegetation, and buildings, line-of-sight for antiarmor weapons is often interrupted.

2. The heavy fog, dense vegetation, hilly terrain and urban growth greatly reduce our ability to acquire and track targets, especially if the targets use concealment well.

The foregoing are two astute conclusions--both significant enough to have a major impact on long range antiarmor engagement. Yet findings by many U.S. practitioners go largely unheeded when these same manuals discuss TOW engagement. It appears simply to be a case of ignoring the facts, and engaging in wishful thinking.

If environmental considerations did not impact sufficiently enough on the practical TOW engagement range, we are faced with yet another critical constraint--that of tactical considerations.

CHAPTER 4

TOW ENGAGEMENT IN THE ACTIVE DEFENSE -- 3,000 METERS OR LESS?

TACTICAL CONSIDERATIONS

If natural fog presents such a constraint on target intervisibility, what will be the impact of tactical smoke? Following the October, 1973, Mid-East War, the Soviets began to question the viability of the tank on the modern battlefield. Soviet writers recognized that the advent of the ATGM added a new dimension to the battlefield, and concluded that:

> "Guided antitank missiles gave to the infantry that which it never had: the probability of destroying tanks with one shot, before the tank could use its own weapons against the infantry."[24]

The concern was real in spite of the fact that they possessed a tank inventory greater than the combined tank strengths of all other countries of the world.

Minister of Defense, Marshal A. A. Grechko, conceded that there had been a temporary shift on the battlefield favoring the technically superior ATGM, but countered with the realization that there was a tactical countermeasure to the long-range system:

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[24]COL. N. Nikitin, "New in the Struggle with Tanks," Banner Carrier, May 1974.

> "The experience of the Middle East events testifies also of the contemplated changes in the methods of tactical actions of the ground troops, in particular of the growing role of long range fire battle. This has been caused by the fact that contemporary weapons allow the carrying of effective fire hitting to enemy tanks starting at long distance. As a result the attacking infantry is left without the necessary support of tanks, suffers great losses and its attack is either frustrated, or loses its strike force, and does not achieve the set goal. For the support of an attack, the reliable suppression of the system of fire of the defense is demanded, especially, long range antitank means."[25]

"The reliable suppression of the system of fire..." One of the best means to neutralize a long-range system is to use a longer range system such as artillery--a system the Soviets have in large numbers. Considering the proliferation of ATGMs that would be expected on the modern battlefield, high explosive artillery alone would not be the answer. Smoke, on the other hand, coupled with high explosive shells would provide obscuration over wide areas of the battlefield, and effectively limit visibility. Based on a Foreign Science and Technology Center estimates, as much as one out of ten incoming artillery shells would be smoke. Additionally, Soviet tanks and the armored personnel carriers BMP can produce their own smoke. This added to the dust and debris of battle would create a shield behind which the attacker would be shielded from direct observation. Existing TOW sights will not penetrate the opaque smoke that the Soviets currently have fielded. Thus, as with fog, if you can't see your target, you can't hit it.

In his book Armed Forces of the Soviet State, Marshal Grechko called for the suppression of defensive fires as a means to overcome the shifting trend in favor of the long-range antitank systems. By

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[25]Marshal A. A. Grechko, Armed Forces of the Soviet State, Moscow, 1975, p. 187.

1977, it appeared as if the Soviet tacticians had acted upon the direction of their Minister of Defense. The 22 November 1977 issue of the Red Star carried an article entitled "With All the Might of Fire" by Major General I. Vorobyev, a Doctor of Military Science. In this lengthy article he describes the manner in which the Soviets intend to suppress the future battlefield. The tactic calls for the rapid and reliable neutralization of the defending fires through the use of massed artillery, tank, air support and small arms weapons before the major assaulting element has entered the battle. MG Vorobyev apparently recognizes the significance of the antitank defense since he specifically addressed the need for suppressing antitank defensive fires. The practice of continuous massed fires really does not constitute a change from existing Soviet doctrine, but merely emphasizes the need to employ continuous fires at long range with a minimum break between the suppressive fires and the assault.

While MG Vorobyev did not specifically address smoke as a suppressive measure, introduction of smoke onto the battlefield has become a standard Soviet tactic. Soviet tacticians recognize that the TOW system requires an optical link between the gunner and the target, as well as a link between the tracker and the missile beacon. Additionally, they recognize that smoke, which is opaque to either the optical or infrared links, will seriously degrade the systems' effectiveness. The Soviets currently have an opaque black smoke already in the inventory that is used in training that would be highly effective against the TOW, and possibly the thermal sight that is to be introduced. Looking

to the future of smoke obscuration, it should be anticipated that development in smoke technology will probably overcome the advent of thermal imagery sights.

A logical question ensues from the discussion involving the massive use of smoke on the battlefield--will not the obscuration caused by smoke have a corresponding effect on the direct fires of the attacker? Certainly it will! However, the attacker, by his own admission, will attempt to neutralize the defender with long range fires, and would like nothing better than to drive onto the objective, and fight at close quarters from their armored personnel carriers. Such a tactic would effectively neutralize large numbers of ATGMs that would proliferate the battlefield.

Here would be an appropriate time to discuss a survey that was conducted in an effort to determine perceptions relative to the impact of environmental and tactical influences on the battlefield. While the survey did not restrict itself to the question of obscuration, the response in this area by the target audience is most interesting.[26]

The target audience for the survey was the 1977-1978 Regular Class of the Command and General Staff College, Fort Leavenworth, Kansas and the faculty of the Departments of Tactics and Command. The survey group was in the rank of Major and Lieutenant Colonel, with 57% having served in Central Europe, but only 39% having a working knowledge or better of the TOW system. It should be noted that only 5% of the respondents had ever fired the TOW. All responders were familiar with

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[26]See Appendix B for exact survey and results.

the existing TOW antitank defensive employment. While all expressed confidence in the TOW system as being effective, only 58% were of the opinion that the existing TOW antitank employment for Central Europe is realistic. Seventy percent of those surveyed were of the opinion that the system is survivable on the modern battlefield, but almost all expressed a concern that protective cover must be added to ensure system and crew protection.

Concerning environmental constraints, 99% responded that wooded areas would hinder engagement; 100% felt that urban sprawl would have some or greater impact on employment; 96% felt that time of day (visibility) would affect employment and 99.3% responded that weather conditions would likewise affect employment.

Of significance interest the survey group indicated their greatest concern relative to the tactical conditions that might limit TOW employment the most was obscuration. A total of 94% responded that this factor alone would diminish TOW effectiveness. The degree of emphasis placed on smoke obscuration as a limiting factor to TOW employment indicates that US field commanders accept the use of enemy smoke on the battlefield as an obvious suppressive means. The only question concerning the use of smoke is to what extent it will cover the battlefield and limit observation. Again there is another side to the TRADOC coined cliche--if you can't see the target, you can't hit it.

Recognizing the Warsaw Pact propensity for employing mass in the attack, 42% responded that the TOW system may be over-subscribed when required to service targets. The rudiments of the principle of

mass is clearly expressed in Biryukov and Melnikov's book, Antitank Warfare.[27] These two Soviet tacticians recognize that any weapon system has its limitation, and so state, "Thus the effectiveness of an antitank weapon can be assessed by the number of enemy tanks it can 'serve'." It becomes obvious that the Soviets have turned to the lessons of World War II in the application of mass to defeat a technically superior weapons system. The two Soviet writers go on to state:

> "Lastly, in cases of combat on equal terms, especially of similar combat units (for example, tanks against tanks) an important factor is the number of these weapons. Here we can in some measure use the law of the British scientist Lanchester, which, if applied to military affairs, states that the total effectiveness of the given quantity of manpower and equipment equals the mean effectiveness of each combat unit multiplied by the squared number of such units in combat.
>
> Lanchester's simple calculations show that, even if one side has, for example, similar weapons that are only half as effective as those of its opponent, but is even 50 percent superior numerically, it still has a chance of winning the battle. If this proportion increases, the opponent may in the end have no chance of winning at all. In this case the active principle is: superior numbers to compensate for inferior skill."

The two writers further state:

> "On the basis of theoretical studies and the law of concentration of forces it can safely be said that, committed to action simultaneously, 20 tanks can quite effectively and swiftly deal with 10 similar tanks. At the same time, if these 20 tanks are committed to action piecemeal, in twos and threes, the 10 tanks fighting simultaneously are quite likely to win."

Throughout their military writings, the Soviets are quick to recognize the effectiveness of the ATGM. The importance the Soviets attach to this weapons system is borne out in the numbers they field,

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[27] Op. cit., Antitank Warfare, pp. 97-99.

and their advanced developments that has produced the FAGOT ATGM that bears a striking resemblance to the French/German designed MILAN ATGM system, and has the characteristics of the TOW.[28] It should be assumed that the Soviets have assessed that a massed attack into a well prepared defense heavily reinforced with antitank systems would become a debacle. Thus, an extension of this assumption is that they would attempt to use their weight of numbers to probe for a weakness along the thinly spread defense, and once finding that weakness, pour attacking forces through the point of rupture. It would be especially at this point that the TOW system would be confronted with far more targets than it could possibly service. It becomes rather obvious that such a tactic could be partially effective in neutralizing the antitank weapons density about which the Soviets have become so concerned.

When the survey group was confronted with a situation involving target servicing and the affects of hostile fire, 47% were of the opinion that the TOW might service two targets before being destroyed. Even this number was qualified by numerous reservations. Correspondingly, 43% felt that only one target could effectively be engaged. As a matter of reader interest, it was the consensus of opinion by members of the Canadian Forces Europe interviewed by this author in September, 1977, that the TOW system would survive no more than one firing. In fact, the opinion stated specifically related to a one-for-one exchange--one tank killed; one TOW destroyed.

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[28] International Defense Review, No. 1, 1978, INTERAVIA, Switzerland, pp. 15-17.

The previously referenced survey reflects the existing attitudes or perceptions of knowledgeable past and future commanders relative to the influence of environment and tactics on the TOW system. But what about the matter of greatest concern--where will the heavy antitank defense effectively begin? The responses to the following question were as follows:

"In your opinion the effective TOW engagement range in Central Europe will probably be (Select One):

1% -- 3,000 meters
4% -- 2,500 - 3,000 meters
8% -- 2,000 - 2,500 meters
34% -- 1,500 - 2,000 meters
42% -- 1,000 - 1,500 meters
11% -- less than 1,000 meters

While 87% expressed an opinion that effective engagement would be at 2,000 meters or less, it is significant that 53% of these were more precise in giving the range as being probably less than 1,500 meters.

Obviously such an opinion is based on a "gut" feeling reinforced by knowledge of the system limitations, the nature of the terrain in Central Europe, and the influence of natural and tactical obscuration. Various scientific studies have been conducted to arrive at an answer to this same question, but using techniques more scientific than a "gut" feeling.

Studies relative to intervisibility conducted at Hunter-Liggett Military Reservation by the U.S. Army Combat Developments Experimentation Center, Fort Ord, California concluded that, "if total engagement times require on the order of 20 to 30 seconds, then well over 50 percent of the intervisibility opportunities would not generally permit enough time for successful target engagement."[29]

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[29]"Simultaneous Line-of-Sight Terrain Effects on Remoted Weapon Systems," Technical Report TR 3-74, CACDA, 10 June 1974, p. 18.

This same study further concluded that the problem of intervisibility could not be overcome by the judicious selection of weapon location. In 490 test cases, only a few systems were found to have only negligible degradation stemming from lack of intervisibility. This test conclusion, the results of which were derived from terrain totally dissimilar and with fewer interruptions in line-of-sight than that of the Central European region, would tend to contradict the assumed results as implied in the various "How to Fight" manuals.

Again, what about the probable engagement range for the TOW system? Based on these tests, the mean range for the first TOW engagement was 2,367 meters.[30] Interestingly enough, evaluation of the test data shows that a target would close approximately 450 meters between time of acquisition and firing the first round. The test report went on to state that, "Most TOW and SHILLEAGH engagements occur on the long segments (prolonged target exposure), especially the 1,200 - 1,400 meter interval (range)."[31] However, as stated previously, the test area terrain does not equate in severity to that of Central Europe.

In an effort to determine the influence of suppression on the TOW system, simulated artillery was introduced into the later tests. The results of these subsequent tests show that the mean engagement range while being suppressed by simulated artillery was 1,940 meters. This is rather significant in that it indicates that the TOW gunner starts to engage his targets sooner than threatened by fire since the mean engage-

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[30]"TETAM Extended Analysis, Final Report," BDM Services Company, 24 December 1974, p. III-8.

[31]Ibid., p. III-24.

[illegible] range without suppression was 1,810 meters.[32] This earlier engagement may indicate a desire on the part of the TOW gunner to quickly fire and remove himself from the area of incoming rounds.

Even under more optimum conditions on the California test range, the mean engagement range was less than 2,000 meters -- more than 1,000 meters short of the desired engagement range in future combat. It would seem that scientific testing would tend to support more closely the "gut" feeling rather than the technical maximum range of the TOW implied in manuals.

Testing under conditions of simulated artillery was absolutely essential considering the number of artillery pieces found in the Warsaw Pact inventory. Considering the preponderance of artillery that the Soviets have at their disposal, they could put 4,000 to 5,000 rounds on each company position in preparation for a deliberate attack. At the outset of an attack (M-Day) NATO possesses a slight advantage in terms of antiarmor weapons (23,000) versus enemy tanks (20,000). However, this advantage would be quickly overcome during the first day of battle due to losses primarily from artillery, and as the days pass, the ratio would turn in favor of the Warsaw Pact with possibly as much as a two-to-one advantage M+16.

In spite of the large numbers of enemy artillery pieces, it would be extremely difficult to saturate the entire battlefield with sufficient artillery to effectively remove the antiarmor threat. Therefore, the Soviets have had to modify their tactics somewhat where antiarmor defenses are concerned.

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[32]Ibid., p. X-5.

In 1973 and 1974 the Soviets introduced two new self-propelled (SP) artillery pieces. The first to be introduced was the M1973 152mm followed closely by the M1974 122mm SP gun. Early intelligence assessments failed to indicate any tactical role other than as indirect artillery support for the advancing armored and motorized-rifle units. However, subsequent assessment would indicate that these two SPs, and in particular the M1974, probably have a very definite direct fire mission. An assessment written by Mr. Andrew W. Hull for the Field Artillery Journal, March-April 1978, entitled "Evolution of Soviet Self-propelled Artillery" states:[33]

> "The new armor support function was not for direct confrontation with enemy tanks as during World War II. Instead, the new SP guns were probably built to provide mobile firepower which could suppress US crew-served antitank systems at the point of Soviet attack. Such a mission for artillery is indicated by Lieutenant General of the Artillery, V. Koritchuk, in the June 1975 issue of "Military Herald," 'As we see, combating the antitank systems of the enemy is becoming one of the most important missions of artillery.'"

Other than in the defense, a direct antitank mission would seem unlikely considering the relatively thin frontal armor of the SPs. By virtue of their very design and employment characteristics, the SPs were specifically intended to support armor and motorized-rifle units in the offense. The organizational distribution of the M1974 in particular would indicate that it will move with the attacking echelons. Considering the Soviet concern over the effects of antitank systems, what better target than the TOW could the SP systems engage while the attacking tanks engage the defending tanks?

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[33]Andrew W. Hull, "Field Artillery Journal," March-April 1978, pp. 11-12.

Soviet technology has also provided the tank with the capability of engaging the TOW with greater effectiveness as well. The new Soviet main battle tank T-72 is assessed by intelligence analysts to have a main armament of 125mm. This increases the standoff range and effective fire by some 500 meters over the previous 1,500 meters of the 115mm smooth-bore gun. This means that, assuming the effective engage range we are discussing is 2,000 meters or less, the T-72 with its high velocity round can detect, fire and destroy an engaging TOW before the TOW missile can reach its target. This capability was true even before the introduction of the 125mm smooth-bore gun, but an additional 500 meters has now been added to the equation. To further enhance their capability, the Soviets are in the process of retrofitting the 115mm gun on the existing T-64s to the more effective 125mm guns.

Soviet artillery officers repeatedly have stressed that artillery fire against antitank positions is much more effective when fired in a direct rather than an indirect mode. It would appear that Soviet technology has given the assaulting forces the means by which to effectively engage the defending antitank systems.

With the advent of the new Soviet SPs comes a shift in tactical doctrine that may appear to be subtle, but is very significant indeed. Any tactician will recognize readily the obvious necessity for artillery firing indirect suppressive fires. However, the Soviets have taken the matter of suppressive fires still further, and have introduced the need for direct suppressive fires by artillery into their existing

tactical doctrine. Marshal of Artillery, G. Pevedelsky, expressed the following admonition in a 1976 Military Herald article entitled "Tactical Training of Ground Forces, Missile Troops and Artillery":

> "In planning artillery fire, it is necessary to divide the fire means and safeguard the direction of them in order that during the course of the entire attack, the antitank means are engaged as a first priority."

The significance of this tactical and doctrinal shift relative to where the main antitank battle will begin becomes evident when we discuss survivability of the TOW ATGM system. Simply put, the Soviets now have more systems that can effectively neutralize the TOW system through direct-fire means. As the TOW begins to engage the approaching armored targets, it will become subject to fires by the SAGGER ATGM or its equivalent, the tank gun, and now the direct fires of the SPs. This further increase in direct fire targeting may require that the TOW system relocate rapidly to a preselected alternate position after firing only a single missile. As a minimum, the increase in numbers of enemy direct-fire platforms will require that the TOW be carefully positioned, camouflaged and protected. The probable necessity of giving up ground after the first round engagement will in itself cause the battle to close closer to the MBA. Movement is essential to TOW survivability once the battle begins.

A computer-assisted manual wargame simulation called the Battalion Analyzer and Tactical Trainer for Local Engagements (BATTLE) being tested at the Command and General Staff College, Fort Leavenworth, Kansas, has provided many lessons concerning the TOW system. The most significant lesson learned relative to the TOW has been that survivability of the

TOW system is in direct proportion with the engagement range -- the greater the range, the greater the survivability.

The BATTLE simulation is conducted on a terrain board depicting an area approximately ten square kilometers around the city of Hunfeld, West Germany. Forces are arrayed to represent Soviet and US forces using the tactics of the respective combatants. The effects of smoke and artillery are entered into the simulation. The defending US force is given the advantage of the defender in that it (1) fires first, (2) is stationary, (3) is in prepared positions, and (4) has the element of surprise.

Relative to the engagement range, early simulations restricted intervisibility for this area to 2,300 meters. However, current tests are evaluating the effects of visibility at 1,000 meters and less. When smoke is introduced into the battle, the range restriction is that distance from the engaging TOW system to the area of the smoke and no further.

In virtually every simulation played, the TOW accounts for the major portion of tank kills. This says a great deal in favor of the TOW system, but some rather significant observations fall out from the testing:

1. With an engagement range of 1,800 meters the kill ratio of TOWs versus tanks is 17:1 in favor of the TOW.

2. As the tank entered the battle at 1,500 meters and was able to effectively return fire, the kill ratio dropped drastically to 7:1 in favor of the TOW. While still a very good exchange ratio, the reduced ratio indicates increased difficult in servicing targets at the

reduced range due to the increased numbers of tanks, and also reflects TOW system losses being increased. For future testing, consideration should be given to the increased effective range of the new Soviet main tank tube to 2,000 meters.

3. As the battle closed to within 1,000 meters, the defender had to withdraw or stand the probability of being overrun and/or destroyed.

It becomes obvious even to the untrained viewer that as the TOW engages at ranges greater than 2,000 meters it has the advantage of being able to engage in a one-on-one struggle with relative impunity to enemy direct fire. The main question is how often can the TOW system be afforded suitable intervisibility as to allow it to take advantage of its technical superiority? As enemy targets continue their advance, and as more targets enter the target window, the kill ratio is quickly reduced. As the tank comes within effective range, the Soviet tank tube, with its high velocity round, begins to gain the advantage over the slower flying TOW missile. In every simulation played to date, there has been at least a single instance of a TOW and tank engaging one another simultaneously. In every case the tank round struck first, rendering the TOW missile ineffective in flight.

As the flight time of the respective projectiles are subject to the influences of time and distance, so too are the firing platforms. The first consideration is that there is a limiting influence on the firing platform--in this case the TOW ATGM. To cite the example used in FM 100-5, page 13-14, if an ATGM attacks a target at 2,000 meters,

the flight time of the missile is estimated to be 10 seconds. If it takes the gunner only 10 seconds to acquire and fire at the target advancing towards him at the rate of 8 mph, the target must remain exposed for a total of 72 meters for the missile to score a hit (See Figure 7). A total of 72 meters of uninterrupted tracking may be possible in the Central European environment. In fact,

TYPICAL MINIMUM SEGMENT LENGTHS (METERS) FOR SUCCESSFUL ENGAGEMENTS

RANGE (METERS)	APPROX. MISSILE FLIGHT TIME (SECONDS)	TANK SPEEDS (MILES PER HOUR)	DETECTION AND ACQUISITION TIMES (SECONDS)				
			10	20	30	40	60
1000	5	4	27	45	63	81	117
		8	54	90	126	162	234
		13	90	150	210	270	390
2000	10	4	36	54	72	90	126
		8	72	108	144	180	252
		13	120	180	240	300	420
3000	15	4	45	63	81	99	135
		8	90	126	162	198	270
		13	150	210	270	330	450

SEGMENT LENGTH IN METERS

FIGURE 7

Minimum Segment Lengths to Achieve a TOW Hit

studies indicate that there are few exposure segments in Central Europe greater than 260 meters, which equates to only 18 seconds for a tank moving at 8 mph. This same 18 seconds correspondes closely to the flight time of a TOW missile at 3,000 meters, and does not take into consideration the acquisition, reaction, and firing time. The second consideration is that targets will enter the target window in increasing numbers and will continue to advance on the defender. Based on an updated BDM Corporation study for input into the "Commander's Battle Book," the average kill rate for the TOW system was given as 0.15 kills per minute (versus 0.30 kills per minute for the M60 tank). Considering the limited number of TOW systems in a company-team sector and the number of tanks advancing onto the defended position, the TOWs could be effectively engaged by direct fire before significant kills could be registered.

A rather significant aspect of combat now played in the BATTLE simulation or addressed in most of the "How to Fight" manuals is the effects of enemy camouflage on target acquisition and tracking. As a personal observer to the 1977 REFORGER Exercise in West Germany, it became apparent to the author that US forces did little in the way of camouflage discipline other than stick foliage in helmet bands, apply camouflage paint to face and hands, and place mud on vehicle markings. The troops of the Bundeswehr, on the other hand, were quick to camouflage even their heavy vehicles. This same state of training can be anticipated on the part of the Warsaw Pact troops, and in particular the Soviets. The effects of suitable camouflage are (a) the target becomes more difficult to detect, (b) when the target is blended with

a compatible background, it becomes more difficult to track and hit, and (c) the delay in acquisition and firing time allows the advancing enemy to close still closer to the defender.

It is necessary to evaluate environmental and tactical considerations jointly, for the two go hand-in-hand. An attacking enemy will attempt to use terrain to his best advantage, picking a time to attack when weather conditions will minimize the effects of the defenders' weapons. Line-of-sight intervisibility will be greatly influenced by the tactics employed and the weather/terrain conditions in the area of the defense. To better appreciate the limits of intervisibility, even on a clear day without the effects of suppression, it will be necessary for the reader to refer to classified studies conducted at Hohenfels, Grafenwohr and Rodenberg Training areas relative to limits of intervisibility.[34]

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[34] Op. Cit., Hardison, pp. 14-15.

CHAPTER 5

SUMMARY AND CONCLUSIONS

A. Summary

This paper has dealt with the probable effective engagement range or envelope of ranges of the long-range antitank guided missile system TOW in the active defense in Central Europe during the period 1978-1983. Discussion was limited to that portion of the battle that will take place just forward of and within the Main Battle Area of the US V Corps defensive sector. The paper focused on one dominant question--if, by virtue of the environmental and tactical limitations imposed on the TOW, the antitank battle cannot begin at 3,000 meters, at what range or envelope of ranges will the TOW antitank battle probably become effective?

In addressing this question detailed discussion was entered into concerning the limitations imposed by the characteristics of the weapon system, the environmental effects of weather and terrain, and the effects of tactics. The evaluation of the resultant research permits the following observations to be made.

Based on accepted technical data, it cannot be argued that the range of the TOW ATGM system is 3,000 meters, and in the case of the improved TOW system, 3,750 meters. Given a clear day, with no obstacles to line-of-sight, and in a benign environment, it must be accepted that the TOW ATGM has a high probability of hitting and even destroying a target at its maximum possible range. It is precisely this sterile

condition, and the propensity of ground commanders to position their defensive weapons systems in positions that afford the greatest range observation rather than where an attacking force can best be serviced that has lead to the belief that effective antitank engagement will begin at 3,000 meters. Were a battle to be fought under these conditions, then the TOW gunner need only concern himself with positioning his weapon as not to have obstacles interfere with line-of-sight, with no sighting requirement within six degrees of the sun, and not requiring a firing angle elevation of more than 20 degrees. In addition, the gunner must consider the effects of back-blast on his positioning and camouflage. Once positioning is accomplished, the crew must then consider suitable withdrawal routes if they are to live to fight on.

However, such sterile conditions in time of combat will not exist, and other factors will enter in such as smoke, battle debris and being suppressed that will be further restrictive in the emplacement and effective engagement with the TOW system.

While not an absolute influence on the effective engagement range of the TOW, but certainly an influence on the TOWs ability to effectively carry out its mission, is the offensive doctrine of the Warsaw Pact. Virtually in every category the Soviets possess a 4:1 or better numerical advantage over U.S. forces and equipment. This advantage, and the Soviet concern for the effects of the ATGMs that will proliferate the battlefield, will allow the attacking force to employ the principle of mass both in manpower and firepower. This will create a problem of having too many targets to service relative to the number of defensive systems available. Recognizing this disparity in numbers,

the Soviets will simply attempt to overwhelm the defending force. To further amplify the principle of mass, the Soviets will attack in echelons, thus overtaxing the defender still further, and consume ammunition. To prevent the defender from effectively destroying the attacking force, the Soviets will pick a time that best facilitates the attack, will maneuver on the battlefield to avoid being hit, and will bypass defending forces where possible. In support of this tactical doctrine have been Soviet advances in technology that have lead to the introduction of a 125mm smooth-bore, fin stabilized main battle tank round, and a very subtle shift in artillery doctrine. Based on Soviet writings, indications are that the Soviets intend to use the M-1974 122mm self-propelled gun-howitzer in the first echelon of the attacking forces to neutralize the antitank systems, in particular, the TOW ATGM system. The significant effect that both of these Soviet systems will have on the modern battlefield is that, if the effective engagement range is 2,000 meters or less, the higher velocity Soviet direct fire systems have a considerable advantage over the slower flying TOW missile.

It was not until the characteristics of the environment and tactics were discussed that some determination of distance began to fall out. In addressing each area investigated, in descending order of effective engagement range probability, we can begin to appreciate the wide variance of opinion, and possibly derive some feel for where that effective engagement range might be.

There are those tactical commanders that credit the effective engagement range of the TOW to be that of 3,000 meters or more based

imply on the weapon capabilities, with no regard given to the constraints imposed by restrictions on line-of-sight. It is this type of commander that is prone to position his TOW system on terrain that will afford the maximum line-of-sight rather than in areas where the enemy is more prone to attack using the terrain to his best advantage. This type of commander may confuse first time observation range with kill range. Considering the flight time of the missile alone, the two ranges are not synonymous. Even when considering the first acquisition and initial engagement, there will exist a variance between this and the effective engagement range. Effective engagement range is defined as being that range or envelope of ranges that give a high probability of consistently hitting the target. Some commanders are still prone to equate first round kill ranges with effective engagement ranges. It is possibly this attitude in particular that has given credence to the 3,000 meter engagement range in the "How to Fight" manuals, and has mislead tacticians as to where the effective antitank defense may be fought.

There appears to be little or no treatment of probable engagement ranges from 3,000 meters down to 2,000 meters range. This is not to say that, where a TOW system can acquire, fire and track a target at ranges within this spectrum, TOWs will not engage. Where there is a possibility to kill a target at the maximum possible range, the TOW will be employed, and with a high probability of success.

It is at the 2,000 meter range and less that most of the fall-out from the investigation seem to center.

Current British defensive doctrine, largely influenced by the effective range of the 120mm gun of the British main battle tank, indicates that effective engagement on the North German Plain will probably be 2,000 meters or less. U.S. tests would tend to support this. Tests conducted at Hunter-Liggett Military Reservation in California indicated that the mean engagement range for the TOW in a test environment was 1,940 meters. However, when test "suppression" was entered, this range dropped off to 1,800 meters.

While 13% of a survey group at the Command and General Staff College at Fort Leavenworth expressed an opinion that the effective engagement range would be between 2,000 and 3,000 meters, a more conclusive opinion was expressed by 87% of the group, stating that the effective engagement range would be less than 2,000 meters. Fifty-three percent were more precise in giving a range of less than 1,500 meters.

This latter range, 1,500 meters or less, corresponds closely with a terrain walk conducted by the author in October, 1977, the results of which support the 1,500 meters or less premise.

Data derived from WWII indicates that the effective antitank engagement range on the part of the Germans was 1,650 meters or less, with 90% of the tank kills coming within this range--this in spite of the fact that the Germans possessed weapons with an effective range of 3,000 meters or more.

Current German studies, based on extensive terrain and inter-visibility studies, conclude that 70 to 80% of engagements will take place at less than 2,000 meters. U.S. studies support this conclusion.

One study in particular conducted by Dr. David C. Hardison concludes that 90% of engagements will come at ranges less than 2,000 meters.

In assessing the computer-assisted terrain simulation BATTLE, the findings were inconclusive relative to the probable effective engagement range. A range of 2,300 meters was played, but this was somewhat arbitrary. An analysis of BATTLE did conclude that as the targets get closer to the TOW system, the ratio of kills falls off, and the TOW has a greater probability of being destroyed.

The Commanding General of the 3rd Infantry Division, MG R. Dean Tice, expressed the opinion that the engagement range of the TOW in Central Europe would probably be between 800 to 1,000 meters.

Environmental (weather) studies indicate that during the fall and winter months, periods of reduced visibility--down to 500 meters or less--are common in Central Europe.

When natural fog is not present to reduce visibility, the Soviets can be expected to employ opaque smoke to screen their advance. By US estimates of Soviet artillery doctrine, one out of ten incoming rounds will be smoke. The resultant smoke cloud will reduce visibility to whatever range it is employed forward, or even on, the defensive position--possibly to the point of reducing visibility to near zero.

B. Conclusions

What immediately becomes evident from evaluating the information available is that there are mixed opinions, historic extrapolations, and scientific studies that support various ranges as being the possible or probable effective long range antitank engagement range. The preponderance

of evidence indicates that the range is not 3,000 as currently planned for, but a range much less than this. Still, based on available data, no single range estimate could be arrived at, but rather a spectrum of ranges.

Ranges that are supported by opinion are not conclusive enough to stimulate a doctrinal change albeit when one considers the weight of this opinion, it should serve to reinforce the conclusion that the effective engagement range will take place at 2,000 meters or less. Additionally, this preponderance of opinion should also influence attitude change away from the existing 3,000 meter range.

Scientific data that incorporates technical capability, environmental restrictions, and the effects of tactics provides the more conclusive evidence as to where the probable effective TOW engagement range will fall. When combining the U.S. tests conducted at Hunter-Liggett Military Reservation in California with those joint U.S./German tests conducted in Central Europe, it can be concluded that the two scientific findings closely support one another--that 80% of engagements will come at 2,000 meters or less.

An extrapolation between current scientific data and actual combat data derived from WWII material may provide the most real-range spectrum. The high side of the spectrum, based on U.S. scientific study, is 1,940 meters--or 2,000 meters for the sake of round figures. The low side of the spectrum, based on WWII historical data is 1,550 meters--or 1,500 meters when rounded down. Thus, the conclusion gained is that the effective TOW engagement in Central Europe under combat conditions will probably fall between 1,500 and 2,000 meters.

The fact that a weapons system can reach ranges of up to 3,000 meters or more does not mean that such ranges can always be exploited. Two factors--varied terrain and frequent inclement weather--when coupled with smoke and debris from the modern battlefield will have a marked influence on the effective engagement range of any weapons system, but in particular, the TOW ATGM. While some engagements may come at 3,000 meters or more, the preponderance of evidence would indicate that the effective engagement range will fall between 1,500 and 2,000 meters. Thus the maximum range of the TOW system does not necessarily equate to the maximum effective range. When the factors of terrain, weather and combat obscuration are considered, engagements between opposing forces may frequently be at very close ranges even though the weapon system is capable of engaging at longer ranges.

If, as the evidence would indicate, the probable effective engagement ranges in Central Europe will fall between 1,500 and 2,000 meters, we should reevaluate tactical thinking to consider these ranges and their possible implications.

CHAPTER 6

TACTICAL CONSIDERATIONS AND RECOMMENDATIONS

In view of the preceding conclusion all available evidence would indicate that U.S. tactical thinking and doctrinal writings must be modified to closely relate to the more realistic probable effective engagement ranges of the long-range TOW antitank systems in Central Europe.

In appraising the current U.S. Army antiarmor employment concept, one would get the impression that it is rather vague, and that this concept places virtually all the eggs in one fragile basket. Examination of this employment concept points out some disconcerting weaknesses:

1. That existing employment concept gives the impression of "piling on" antitank guided missile systems regardless of the capability of defending units to effectively employ these systems.

2. That the very heart of the antitank defense focuses on the antitank guided missile, and in particular, the TOW, albeit in concert with other weapon systems.

Before we can effectively address these two points in detail, it is necessary to first take another look at the TOW ATGM system. Some of the advantages of the TOW system are:

- o They possess long-range accuracy and high kill probability.
- o They are relatively light and thus man-portable.

o They are relatively inexpensive (when compared to a tank).

o Once fired, the missile can be command-corrected.

Some of the disadvantages of the TOW system are:

o Gunners must be highly trained.

o The 14.7 to 17 second flight time of the missile at 3,000 meters (when compared to a high velocity round) is excessive.

o The gunner must have a good visual contact with both the missile and the target, and must track the missile throughout flight to point of impact.

o Upon firing, the TOW has a launch signature and back blast, making it difficult to provide hardened protection.

o The system is easily suppressed by direct and indirect fire.

o Current TOW warheads are HEAT (shaped-charge) rounds, which may be rendered ineffective or greatly degraded with the introduction of Chobham-type armor or space-laminated armor.

Relative to the impression of "piling on" TOW ATGMs this may not, in itself, be a weakness. As previously discussed, the Soviets are very concerned about the proliferation of ATGMs on the modern battlefield. This impression of numbers may be a contributing factor to the overall deterrence equation. However, there is some serious doubt as to the infantry's ability to effectively employ these systems. To defeat a massive armored attack, antiarmor systems must be massed quickly and efficiently. Considering the threat, one can easily see that it is desirable to have antitank systems in large numbers and in

depth. However, the defending force must be given the means to effectively transport these systems, and be provided some degree of protection to afford survivability. The question of increased numbers has already been considered. As addressed in a report to Congress by the Secretary of Defense, dated 28 January 1978, entitled Rationalization/Standardization Within NATO, the following comment concerning ATGMs was disclosed:

> "NATO nations have agreed to modernize and/or increase their antiarmor forces. This will represent an increase by more than 47,000 over current holdings of ATGMs to take place over a two-year period--an increase by one-third over previous holdings. Approximately one-half this 47,000 figure will be the US produced TOW ATGM."

Mobility of the TOW in combat goes well beyond simply picking up the system and moving a few meters to a new position. In order to effectively survive, the system must be able to move quickly after firing one or possibly two missiles from a pre-selected position. Infantry forces do not have suitable means providing the necessary protection to transport the TOW system. TOWs in a ground-mounted role are extremely vulnerable to suppressive fires. TOWs mounted on mules or jeeps are equally vulnerable, but at least these systems have the ability to fire and quickly move, even though they are not afforded any degree of system protection. The possible introduction of the improved TOW vehicle this year in Central Europe will greatly improve the situation, but 1,976 such vehicles are simply not sufficient to provide the mobility desired to mass antitank systems. Considering the cost of adding an armored tracked platform, one might argue that the increased cost does not

warrant production of more such TOW vehicles, or that the additional money might be better put to advantage producing other systems. The counter to this argument is obvious when one considers that the new XM-1 main battle tank now in production is approaching one million dollars per copy, and there will always exist a need for integrated antitank systems of varying ranges and types.

In addressing the second point--that existing doctrine and force organization is highly dependent on the TOW ATGM for the conduct of the antiarmor defense--we must not fail to realize that an effective antiarmor defense is made up of the total integration of available weapons systems that can do the job--air, artillery, tanks, antitank, etc. The Soviets, in particular, effectively integrate their systems, but with greatest effect in the area of artillery, since virtually every artillery weapons crew is assigned and continually trained in the antitank role. However, in the case of the U.S. the only dedicated antitank weapons, with the exception of the few remaining 90mm and 106mm recoilless rifles that are still around, are the antitank guided missiles. Of the ATGMs, the TOW is the backbone of our antitank defense, with its longer range and greater kill capability. There are currently no high velocity antitank guns in the Army inventory, nor are there any true armored antitank gun systems. The void in high velocity antitank guns could come back to haunt us considering the reality of urban sprawl in Central Europe.

As discussed in the introduction, U.S. force structure and consequently the resultant doctrine have been driven by fiscal constraints.

To say that doctrinal writers must be challenged to make U.S. doctrine an effective tool against the potential enemy threat capabilities--his doctrine, tactics, equipment, and organization--addresses itself to but half the challenge. Congress must respond by giving the military the tools with which to effectively carry out a workable doctrine.

Existing U.S. doctrine calls for the employment of the TOW system in the covering force area, and to be used continuously during the course of the battle in the CFA. Systems will move back to the main battle area and join TOW systems already positioned in the MBA to strengthen the antitank defense, and provide depth. A potential weakness is that sector of the defensive area that invovles the hand-off of the battle from the forces of the covering force to the defending forces in the MBA, especially if attacking forces are intermingled with the withdrawing covering force.

A possible alternative to this tactical employment might be in the form of a similar scenario, but with one major modification. Antitank systems could be used in the CFA in identically the same manner in which they are currently intended. TOW defenses in the MBA would be selected and prepared in depth in exactly the same manner that it is currently anticipated. The major departure would be the selection of positions, and the positioning of TOW ATGM systems well forward of the MBA--possibly as far forward as ten kilometers. This would involve not just some, but all TOW systems that are designated for the defense of the MBA. The advancing enemy would fully expect to be facing the TOW system during the fight in the CFA, but in

relatively limited numbers. Imagine the surprise to the enemy and the increased destructive firepower as the enemy force entered this thickened covering force area with TOWs firing from multiple ambush positions. The TOWs would fire from ambush, score a kill, and quickly withdraw to a preselected second, third or more ambush position. Such a tactic would have the effect of more realistically confusing the enemy as to the actual location of the main battle area, accomplish more effective attrition, cause the enemy to maintain a deployed advance, slow the movement so that other weapons systems can take their toll, and off-set the possible effects of reduced visibility. While intervisibility may be limited to 1,500 meters for example, this 1,500 meters would be effective for the distance it is employed forward - or possibly ten times with a 1,500 meter range rather than once. Such a sniping and running battle would be fought all the way back to the MBA where the TOWs would take up pre-selected and prepared positions in the MBA to fight an antitank battle as is currently perceived.

The overall antiarmor defense must be controlled at the highest possible level to insure the proper positioning of systems along the avenue of the main thrust. Execution of the defense would be carried out at the lowest possible level with detailed planning and suitable communications to insure effective target selection and destruction. The problems relating to command and control, target selection, and weapons control should be considered for future extensive study.

In view of the conclusion drawn from this thesis, something must be done to make the antitank defense more viable. If no change is made, the TOW ATGM system will be subject to piecemeal destruction, restricted mobility, and being overrun by a numerically superior enemy force.

Recommendations:

1. That the existing concepts U.S. antiarmor employment, and in particular those relating to the TOW ATGM system, be reexamined and rewritten to best counter the potential threat.

2. That an antitank system be developed and fielded that has a fire-and-forget capability, has greater flight velocity, is protected, and mobile.

3. That existing tactical writings and training be changed to reflect a more precise probable effective engagement range in Central Europe of 1,500 to 2,000 meters.

APPENDIX A

APPENDIX A

AUTHOR BIOGRAPHICAL SKETCH

LTC John R. Angolia is a career soldier, dividing his time between infantry and intelligence assignments over the past twenty years. He commanded a rifle company in Korea in 1965. His credentials stem from intelligence training and assignments in tactical and strategic intelligence at Joint Commands and higher.

During the period 1972-1975, LTC Angolia was the Warsaw Pact analyst at Headquarters, European Command. In this capacity he was the first Western intelligence analyst to detect and assess both the M-1973 152mm and M-1974 122mm self-propelled howitzers. He also assisted the US delegation to the SALT Talks in determination of the military balance.

LTC Angolia is the author of seven military related books, the most recent entitled The US War Machine to be released in August, 1978.

He is currently assigned as an author-instructor, Department of Tactics, Command and General Staff College, Fort Leavenworth, Kansas.

APPENDIX B

APPENDIX B

Survey

This survey is being conducted in support of a MMAS thesis in an effort to determine at what range the TOW antitank (excluding helicopter mounted) defense in Central Europe will probably take place. The period considered is 1978-1982. It is considered that innovations such as the thermal sight will not be fielded prior to 1982. While the extended range TOW is a factor, the maximum range of the TOW is considered to be 3,000 meters.

I solicit your response to this survey. The results of this survey will be coupled with scientific findings, and may have an impact on our current antitank defensive doctrine. Please complete the survey and return to LTC John R. Angolia, Room 339, Bell Hall, prior to 31 January. Your cooperation in completing this survey is appreciated.

PART I - BACKGROUND

1. Have you ever served in Central Europe? Yes 57% No 43%

2. Familiarity with TOW antitank guided missile system: Very familiar 8% working knowledge 31% only what I've read in books 51% never seen a real one 5% not familiar 5%.

3. Have you ever had a direct association with the TOW ATGM system? Yes 21% No 79%.

4. Have you ever fired the TOW? Yes 5% No 95%.

5. Are you familiar with the current TOW antitank defensive doctrine? Yes 100% No ___.

6. Select one or more of the following that best describe the TOW system:

   a. - What you can see you can hit.
   b. - System reliability is in excess of 90%.
   c. - System accuracy is a function of training.
   d. - The system is not very mobile unless mounted on a vehicle.

PART II - SYSTEM EMPLOYMENT

Please select one response that most closely reflects your attitude concerning the TOW system and the existing TOW antitank defensive doctrine relative to Central European environment.

7. The Central European terrain maximizes the 3,000 meter range of the TOW: Yes 19% No 81%.

8. Wooded areas will 99% will not 1% hinder engagement.

9. Urban sprawl (cities, towns, villages) will have major 50% some 50% no 0% impact on employment.

10. Time of day will 96% will not 4% affect employment.

11. Weather conditions will 99.3% will not .7% affect employment.

12. What major problem area will most affect employment? (Select one or more)

94% a. Obscuration (smoke, fog, rain, snow, dust).
79% b. Obstacles (buildings, trees, etc.).
57% c. Terrain (Central Europe).
12% d. Target selection (tank vs APC).
42% e. Target servicing (when faced with more than one target).
4% f. System reliability.
5% g. Vague employment doctrine.

13. In your opinion, do you think?

a. The TOW system is effective Yes 100% No ___.
b. The existing TOW antitank defense for Central Europe is realistic? Yes 58% No 42%.
c. That targets will normally be engaged at 3,000 meters? Yes 2% No 98%.
d. The TOW is a survivable system on the modern European battlefield? Yes 70% No 30%.
e. The system will be degraded by having to select from too many targets? Yes 38% No 62%.

14. The TOW will be capable of engaging how many targets before being forced to displace or being destroyed:

One 43%
Two 47% (but with many stated reservations)
Three or more 10%.

15. In your opinion the effective TOW engagement range in Central Europe will probably be (select one):

1% a. 3,000 meters.
4% b. 2,500-3,000 meters.
8% c. 2,000-2,500 meters.
34% d. 1,500-2,000 meters.
42% e. 1,000-1,500 meters.
11% f. Less than 1,000 meters.

16. The 3,000 meter range is

65% a. Too much for Central Europe.
4% b. Not enough for Central Europe.
31% c. Optimum for Central Europe.

Please attach any additional remarks you might wish to provide on a separate piece of paper. Thank you.

JOHN R. ANGOLIA

BIBLIOGRAPHY

SELECTED BIBLIOGRAPHY

PRIMARY SOURCES

Studies

"A Computer Program for Evaluating the Effectiveness of HEAT Munitions Against Armored Targets" (U), Picatinny Arsenal, January, 1969.

"Analysis of Combat Data--1973 Mideast War" (U), CACDA, July 1974.

"Analysis of NATO-Warsaw Pact Antitank Capabilities" (U), General Research Corporation, July 1973.

"Antiarmor Studies Program" (U), Institute for Defense Analysis, February 1973.

"Antiarmor Systems Program Review", U. S. Army Europe, 5 January 1977.

"Antiarmor Systems Program Review 1976 Scenario Attendee Fact Book", Combined Arms Center, 27-28 April 1976.

"Antiarmor Systems Study", U. S. Department of the Army, Training and Doctrine Command, 17 December 1976.

"Antitank Weapons Proliferation Concept", U. S. Army Combat Developments Command Concepts and Force Design Group, September 1972.

"Army Concept Paper on Antiarmor" (U), U. S. Department of the Army, Training and Doctrine Command, November 1976.

"Army Test and Evaluation Command Report of USATECOM Project No. 8-MI-080-TOW-001" (U), Aberdeen Proving Ground, MD, April 1970.

Close, Robert. Europe Without Defense? 48 Hours that could change the World. Arts and Voyages, Brussels, 1976.

'Simultaneous Line-of-Sight Terrain Effects on Remoted Weapon Systems," Technical Report TR 3-74, Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas, 10 June 1974.

"Tactical Effectiveness Testing of Antitank Missiles (TETAM) Extended Analysis, Final Report", BDM Services Company, 24 December 1974.

"The TOW-SHILLELAGH Congressional Issue, 1969-1970", U. S. Army War College Case Study, COL James V. Irons, 8 March 1971.

"TOW Heavy Antitank Assault Weapon"(U), Hughes Aircraft Co., 7 July 1965.

"TOW Heavy Assault Weapon" (U), Eighth Army, 28 January 1974.

Book

Biryukov, G. and Melnikov, G., Antitank Warfare, Progress Publishers, Moscow, 1972.

SECONDARY SOURCES

Books

Lewis, William J. and Wiener, Friedrich, The Warsaw Pact Armies, Carl Ueberreuter Publishers, Vienna, 1977.

London Sunday Times, The Yom Kippur War, Doubleday and Co., Inc. Garden City, NY, 1974.

The Military Balance 1977-1978, The Institute for Strategic Studies, London, 1977.

Articles

Magyera, Stephen N., Jr., Troubleshooting the New Division Organization, Military Review, July 1977.

Military Publications

U. S. Department of the Army. Brigade and Division Operations (Armor/Mechanized) FM 71-100 (Draft). May 1977.

U. S. Department of the Army. Operations, FM 100-5, 1 July 1976.

U. S. Department of the Army, Training and Doctrine Command. Range and Lethality of U. S. and Soviet Antiarmor Weapons, TRADOC Bulletin No. 1, 30 September 1975.

U. S. Department of the Army, Infantry School, TOW System Evaluation Directorate of Evaluation, Report No. 3, December 1976.

U. S. Department of the Army, Infantry School, Tactics and Techniques for Employment of the TOW Weapon System, March 1973.

U. S. Department of the Army, HQ, 82nd Airborne Division, Airborne Antiarmor Defense, 16 February 1977.